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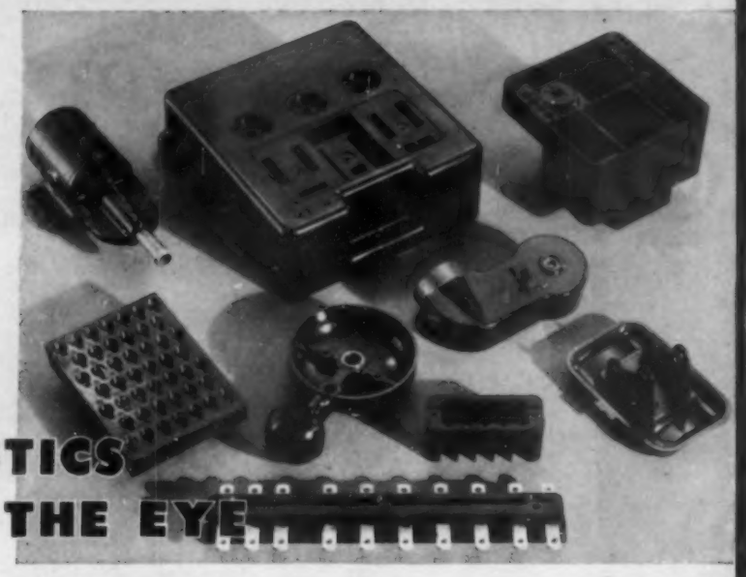
MODERN PLASTICS

MAY 1946

THERE ARE MORE USES OF DUREZ PLASTICS THAN MEET THE EYE



In the electrical manufacturing field alone there are hundreds of "hidden" applications for Durez phenolic molding compounds. For example, take the molded Durez parts illustrated. They are parts of various Minneapolis-Honeywell electrical control devices. When the complete controls are assembled and in use, these plastic pieces are not all noticeable...bearing out the statement that there are more uses of Durez plastics than meet the eye. Furthermore, this axiom holds true throughout practically all fields of industry. *Chances are there are several "hidden" (as well as obvious) applications for Durez phenolic plastics in the products you manufacture*

Why Plastics?

Plastics have long been considered a vital material in the manufacture of electrical equipment. For many parts ...such as those illustrated...experience has proved that they are far superior to any other material.

Why Phenolic Plastics?

Because the phenolics are the most versatile of all plastics, alert design engineers have learned to start with this group in searching for the plastic that fits their job. Such properties as high dielectric strength, arc resistance, dimensional stability under temperature extremes, impact strength, and heat resistance...to mention a few...make these ideally suited for many of the thousand-and-one small parts that go to make up the industrial or consumer electrical unit of today.

Why Durez Phenolic Plastics?

During the past 26 years Durez laboratory technicians have actively participated in the successful development of thousands of products of which phenolic plastics have been an integral part. Combine this rich background with the fact that there are more than 300 versatile Durez phenolic molding compounds and you can readily understand why leading manufacturers everywhere look to Durez for the plastics that fit their jobs.

Experienced Assistance Available

The benefits which the experienced Durez staff and a wealth of proved product development data can offer to you and your custom molder are available for the asking. Durez Plastics & Chemicals, Inc., 55 Walck Road, N. Tonawanda, New York. *Export Agents: Omni Products Corporation, 40 E. 34th St., New York 16, New York.*

DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

To a *Catalin* accompaniment

...the PLAYANO renders enjoyable "one-finger" performances!

Those who are fond of music . . . and yet shy away from the piano through an inability to make their ten fingers perform . . . will welcome Playano! Easily positioned over the standard keyboard, it converts a simply numbered, one-finger technique into striking a series of harmonically related chords.

Those who love and admire nice things will be further appealed to by Playano's beauty. Exquisitely encased of Catalin, the gem of plastics, Playano is harmonious *outwardly* as well as *inwardly* — And, should one be intrigued to discover "what makes Playano play", we might add that the key tabs and concealed striker action were molded of lightweight, dimensionally stable Loalin . . . Catalin's polystyrene molding compound.

Catalin's rich colors — its beauty, brilliance and physical properties — all offer much to product designers. Casting techniques, too, now so highly developed, encourage the planning of intricate custom shapes without the need for expensive and time-delaying molds. Members of our service staff will be glad to discuss these and other Catalin advantages with you. Inquiries invited!

CATALIN CORPORATION
1 PARK AVENUE, NEW YORK 16, N. Y.

Credits: Van Dyke Hill, *Inventor;* Maurice A. Lichten, Inc., *Fabricators and Molders;* Chicago Musical Instrument Co., *International Distributors.*

CATALIN
THE GEM OF PLASTICS
Catalin

CAST RESINS • LIQUID RESINS • MOLDING COMPOUNDS

MODERN PLASTICS*

AND PLASTICS*

VOLUME 23 MAY 1946 NUMBER 9

CONTENTS

General Section

Plastics cannot work miracles..... 7

More plastics in juke boxes..... 75
Utility the thing in vending machines..... 80
Adding punch to amusement devices..... 82
The color inherent in plastics continues to be one of the principal reasons for the use of these materials in juke boxes and coin machines. But this type of plastic application is being supplemented by more functional parts—the windows of vending machines, to name but one.

Color in cold moldings..... 83
J. Earl Simonds—Outstanding is the ability of these new compounds to be cold molded automatically with no heating or after baking.

Changing styles in iron handles..... 85
J. H. Du Bois.

Extruded hose and shelf edging..... 89
Color, light weight, long wear and ease of maintenance combine in extruded cellulose acetate butyrate shelf edging and polyvinyl chloride garden hose.

A boy's own molding press..... 94
A toy molding press has now been introduced on which youngsters can turn out cellulose acetate toys.

A low-density structural core..... 96
R. E. Maier.

Precision labeling with reinforced plastics.. 98
Prescott Fuller—In a labeling machine the parts that hold the bottles or containers in position while the label is being attached must be to exact tolerances. To achieve this precision, bottle and label holders are produced from resin impregnated glass cloth molds.

From trim tab motor to hand mixer..... 100

S.P.I. third California conference..... 102

Annual Spring session of the S.P.I..... 109

Plastic materials supply situation..... 116a
W. Stuart Landes

Plastics-Engineering Section

The duplicating of plastic molds..... 117
Islyn Thomas and John Hohl—If plastics plants are to compete with other materials in the civilian markets, the price of molds must be cut to a minimum. To this end, many plastics plants have purchased duplicating machines to produce identical cavities in multiple-cavity molds.

A comparison of laminated materials..... 126
J. C. Pitzer—The tip-in chart accompanying this article presents all the pertinent facts concerning high pressure laminates.

Production of honeycomb cores..... 127
J. D. Lincoln.

Cellulose ester plastic sheeting produced by nonsolvent continuous extrusion..... 132
Method of producing cellulose ester plastic can now be produced in continuous sheet form in widths up to 24 in. using a standard extruder and specially developed accessory equipment.

Technical Section

High pressure polymerization of ethylene... 141
A report presented at the 26th Kuko (Plastics Committee) meetihg in Ludwigshafen on Feb. 15, 1943 by Dr. Hopff and Dr. Goebel, I. G. Farbenindustrie A.-G. This translation was prepared by Mrs. I. G. Callomon and Dr. G. M. Kline, National Bureau of Standards.

Correlation between strength properties in test specimens and molded phenolic parts, Part I. Tensile and flexural properties... 146
P. S. Turner and T. H. Thomason.

Plastics digest..... 156

Technical briefs..... 160

U. S. plastics patents..... 164

News and Features

Plastics in review..... 90

Plastics products..... 104

Plastics stock molds..... 108

Books and booklets..... 166

New machinery and equipment..... 178

News of the industry..... 182

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* Reg. U. S. Patent Office.

GEON PRODUCTION IS BEING DOUBLED

● By early 1947 the production of GEON polyvinyl materials is planned to be more than double the rate of present production. This expansion is already under way—to make GEON available in desired quantities to old customers—to make possible the use of GEON by new customers who are now limited to experimental quantities.

This new production will, we hope, do away with the present need for allocations which, despite the end of the war and substantial production increases during 1945, we have been forced to resort to in order to make fair distribution of these increasingly important raw materials.

We hope you'll be pleased to know that, before too long, you'll be able to get GEON in greatly increased quantities. For help with development problems, please write Department I-5, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, O.

Geon
Polyvinyl Materials

B. F. Goodrich Chemical Company

A DIVISION OF THE B. F. GOODRICH COMPANY

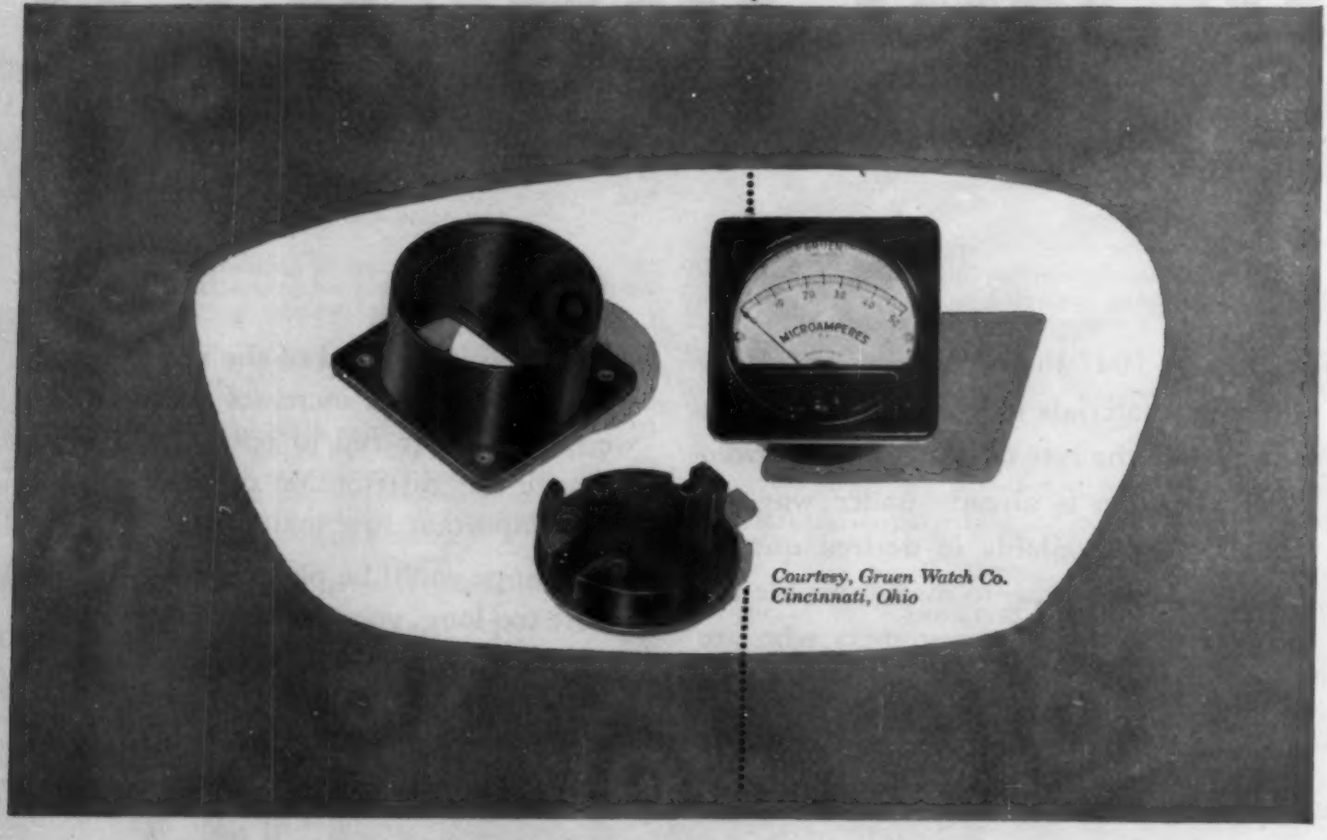
Case Histories from the **RICHARDSON** *files*

MOLDED PARTS

Problem: *Produce a case for vital electrical indicating instruments. Must be lightweight, durable, high in dielectric strength and have a permanent finish.*

Solution: *Richardson Plasticians* used Molded INSUROK, Grade 1, finding in this specific grade and type a material ideally suited to the requirement. The result was a meter case having the precise characteristics desired.

Richardson Plasticians are well equipped to help you solve your plastic problems—whatever they may be. For in the large family of INSUROK *Precision Plastics*, there is a type and grade to meet practically any requirement. Next time let us mold or laminate the kind of INSUROK you should have for better efficiency on your job.



Courtesy, Gruen Watch Co.
Cincinnati, Ohio

INSUROK *Precision Plastics*

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Plastics cannot work miracles

Our friends are expecting synthetics to be the dominating factor in a new millennium. Plastic houses, automobiles, unbreakable furniture, indestructible toys and dishes—even plastics good enough to eat (chewing gum, for example) will be in existence soon according to them.

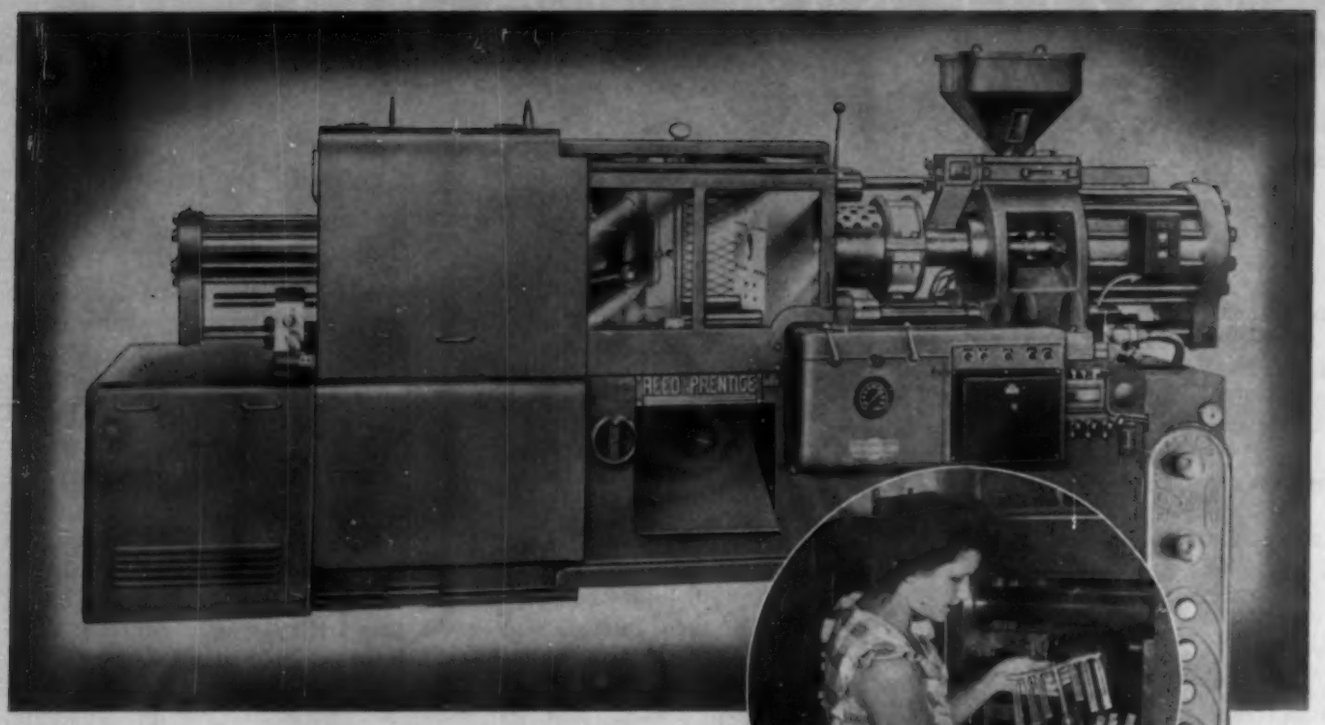
These friends are ambitious for the industry. They have picked up the notion that plastics will sweep aside other materials like a bulldozer erases a sapling. One such example of a praiseworthy but misguided effort to be friendly was that of a national magazine cover depicting a dreamy businessman toying with colored plastic chips while he envisioned the future showing a transparent topped truck, a plastic office building and a plastic airplane. No one dares to say that these things will never happen, but it is significant that these bizarre ideas concerning plastics' future are seldom put forth by recognized spokesmen in the industry.

The industry leaders themselves are for the most part cautious and careful in recording their opinions of the future. They continually play down future prospects until they are reasonably satisfied that a new development will meet the requirements of daily use. Yet, ironically enough, they are often charged with overselling their still developmental product while the real offender is some enthusiast who has picked up a hot tip from a friend who knew a friend who was close to the president of Rip Snorter Plastics, Inc. Then bingo! A brand new and wonderful plastic is born that is going to glamorize Cinderella. Eventually Cinderella learns that plastic garments are not the sole requirement for glamour—that plastics are not necessarily miracle workers and have limitations, just as other materials have limitations. Then she becomes irate and condemns plastics as such. And remember that her introduction to plastics, likely as not, came from a free, friendly tip that plastics was the answer to her problem. When it fails to perform a miracle she is sour and disillusioned—the industry takes a rap for a sales story invented by would-be friends whose gratuitous contributions are unfortunately more harmful than helpful.

But embarrassing as these friends sometimes become, their mouthings are as nectar in comparison to the venom spewed out by our enemies, many of whom are in our own ranks. Most common are those who carelessly use the wrong material in order to obtain quick monetary return. Then there is the individual who would combine one eighteenth of an ounce of plastic with any cheap material he can get for filler and calls it plastic. Unfortunately both seem ignorant of the damage they are doing to their own future market.

But the most dangerous of the group is the so-called plastics "expert" who offers his high-powered advice on what or what not to buy. His company, or client, taking this phoney advice, stocks up on a line of items that prove faulty. The expert plastic buyer then blames the plastics industry for selling an inferior product which he himself had recommended.

In any case Cinderella is deceived either by the loose tongued gossiper or by the machinations of a wolf whose whine can be heard from New York to Chicago when Cinderella figuratively accuses him of false pretence. Cinderella is lost as a customer of the industry until she is reeducated on the practical applications of plastics.

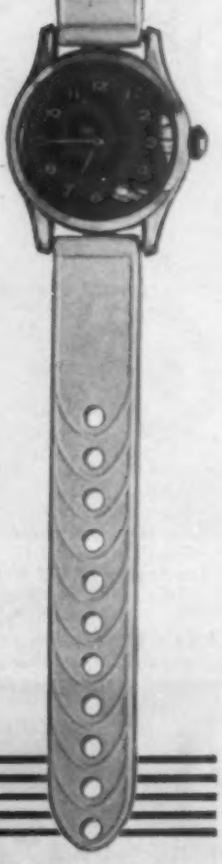


"The Right Time and Place" for PLASTIC!

The 10D-8 Oz. Reed-Prentice Injection Molding Machine (shown above) played an important part in the production of the two-piece PLAYBOY wrist watch strap, originally designed for military use in the tropics — now available to civilians.

Made in several attractive colors from polythene, to a controlled thickness of 0.038", from a 12 cavity mold, by Nosco Plastics Co., Erie, Pa., for the Pla-Safe Plastics Corp., Buffalo, N. Y. — this sturdy wrist watch strap has strength, flexibility, resistance to perspiration and is not affected by body acids, salt air, water, humidity or extremes of climate. Truly — "the right time and place" for plastics!

Reed-Prentice Injection Molding Machines are engineered for precision molding of thermoplastics to mass production speed — are convenient and safe to operate — easy to maintain. Available in 22, 16, 12, 8, 6 and 4 Oz. sizes.



INJECTION MACHINES

REED-PRENTICE CORP.

WORCESTER MASS., U.S.A.

NEW YORK OFFICE:
75 West St., New York 6, N. Y.

CLEVELAND OFFICE:
1213 W. 3rd St., Cleveland 13, Ohio

To Get the Right Molding Powder First...

TRY MAKALOT First

...eliminate failures, delays, rejects!

And this is not a *claim*, but a *conclusion* based on the experience of some of the country's leading molders, who—after solving literally scores of molding problems in a matter of hours or days, *where weeks or months had been lost experimenting with other materials* —now *always* try Makalot first.

So many intricate pieces with such widely varied *required* characteristics have been molded of Makalot that it is only logical—if you have a difficult molding problem—to assume that your chances of solving it successfully *and quickly* are better with Makalot.

Interlake offers you low loss Makalot Compounds for high frequency applications, non-cracking compounds for molding around inserts, non-shrinking, heat resistant, general purpose, high impact, or with brilliant surface lustre—and—every one has been proved in successful use by some of the foremost molders.

BRING YOUR MOLDING PROBLEMS TO INTERLAKE. Interlake offers a complete line of Makalot phenol formaldehyde thermosetting compounds—in various forms, in a wide range of flows. Write Interlake Chemical Corporation, Plastics Division, 1911 Union Commerce Building, Cleveland 14, Ohio.

INTERLAKE CHEMICAL
Corporation
• PRODUCTS FROM COAL •

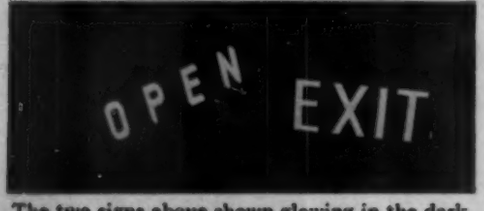
Makalot Plastics

Glamorous—and PRACTICAL!

After normal exposure to natural or artificial light, a phosphorescent plate for an electric circuit outlet is easy to locate and use in the dark. (Plate is molded from the Marco Chemical Company's MR resin, pigmented with a Horse Head Phosphorescent Pigment, having a long afterglow—8 to 10 hours.)

Luminescent Plastics, Using Horse Head* Luminescent Pigments, Offer Many Opportunities for New, Commercial Applications

Greater value can be added to electric signs in several ways with the use of Horse Head Phosphorescent Pigments. ● The sign on the left employs plastic raised letters, and a sheet of phosphorescent plastic, which is inserted between the letters and the light source. This sheet continues to glow when lights are out. ● On the sign on the right, the afterglow properties are obtained by spray-painting the reverse face of the sign with phosphorescent paint. ● The effect also may be obtained by printing, painting, or silk screening the sign on a sheet of luminescent plastic.



The two signs above shown glowing in the dark, after all lights are out.

LUMINESCENCE—in the form of *glowing* plastic products—is making sales news in the plastics industry. A number of luminescent plastic products are now in the markets, or in production. Other items are in the design, or plan stage—items that are:

—easy to find in the dark
—provide unusual color and decorative effects
—act as safety aids
—provide light which is easy on the eyes, etc.

Plastic materials,** pigmented with Horse Head Fluorescent and Phosphorescent Pigments, are ready and proved for commercial applications. Phosphorescent types may be obtained in colors which, after short exposure to daylight or lamplight, glow in the dark for as long as ten hours. Like storage batteries, they can be charged and recharged indefinitely by exposure to light. Fluorescent types transform "black" light into a complete range of visible colors.

Our technical staff is prepared to work with you, your molder or plastics supplier on any phase of luminescent plastics applications.

*Reg. U. S. Pat. Off.

**Molding granules, powders, sheets and cast films have been developed by leading producers. If you are in doubt where to obtain any particular type, write us for further information. (The New Jersey Zinc Co. does not manufacture plastics—we supply the Luminescent Pigments used by plastic manufacturers.)

THE NEW JERSEY ZINC CO., 160 Front Street, New York 7, N. Y.

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HORSE HEAD PRODUCTS
New Jersey zinc

CELANESE* PLASTICS

ring the cash register

A National Cash Register is built for hard wear. It is designed to stand up to the punishment of fast starts and quick stops, and may record as many as 30 million sales in the course of its lifetime! That is why the best engineering skills and the finest materials must go into the manufacture of these modern machines.

The Celanese plastic items shown on this page are working parts of National products, both cash registers and accounting machines. They are manufactured in several different ways, and full advantage is taken of the qualities of the material and the benefits possible in plastics production. Some are injection molded in multiple cavity molds, others compression molded. Fabricating methods to produce the finished parts include laminating, machining, cementing and inking of recessed lettering.

In your product planning, the advice of our technical service staff may indicate how and where you can use plastics most effectively. The war experience of Celanese plastics can give you new insight into what these materials can do in improving products and reducing costs. Celanese Plastics Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y. *Reg. U.S. Pat. Off.

LUMARITH*

A Celanese Plastic*

LUMARITH Cellulose Acetate
Ethyl Cellulose
FORTICEL† Cellulose Propionate
CELLULOID* Cellulose Nitrate
VIMLITE* Plastic Glazing

†Trademark

"THANK YOU" sounds so good!

We heard those nice words recently from Sylvania Electric Products, Inc., and from Scintilla Magneto Division of Bendix Aviation Corporation for our part in helping them produce America's key war weapons . . . the Proximity Fuze and vital airplane ignitions.

MR. H. HANNI OF SCINTILLA WROTE . . .

" . . . . Your production efforts were a contribution to the winning of the war, and you have every right to be proud of them."

SAID MR. JAMES H. DRAY OF SYLVANIA . . .

" . . . . it was through your help that we were able to receive this acknowledgment (twenty-two "E" awards) of thanks from the Navy."

The facilities and know-how of Prolon Plastics are at your service. If you have any kind of plastics problem, come in to see us, or write to

PROLON PLASTICS

A Division of the Pro-phy-lac-tic *Brush Co., Florence, Mass.*

Will She ask for YOUR PRODUCT?

One way to assure consumer demand for your product is to make use of the valuable properties of glass wherever possible. Housewives need not be sold on glass. Their years of experience with it have taught them the value of its utility, cleanliness and permanent luster. Recently they have learned to respect its durability as well.

Many design engineers have given added sales appeal—improved performance—to a product by the use of glass. Others have, by means of glass, created products which would otherwise have been impossible. Perhaps you, too, can take advantage of the consumer acceptance of glass.

THOUSANDS OF TYPES OF GLASS

From the thousands of glass formulae developed by Corning Glass Works, you can secure the one with the combination of properties which meets the specific requirements of your product. Corning Engineers are ready to give you the benefit of their years of experience in selecting the glass best suited for your particular use.

CORRECT DESIGN IS IMPORTANT

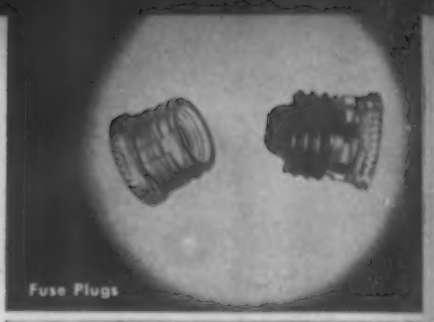
The vast knowledge and experience of Corning's Product Engineering Department in the development of more than 40,000 different glass products provides a valuable source of data on which to base new designs. Corning can assist you in designs that will make full use of all the valuable properties of glass.

PRODUCTION FACILITIES

Whether your requirements call for a single glass part of intricate design or thousands of similar parts, Corning has the engineering and manufacturing facilities to help you. Manufacturing techniques permitting the automatic production of glass parts in quantity and at low cost also assure you of uniform quality. Glass can be pressed, blown or drawn either by hand methods for small quantities or by high speed, automatic machinery. Precision tolerances can be secured by carefully controlled finishing operations.

Corning Engineers will gladly help you to select the best glass for your particular purpose. They have the glass knowledge —the "know-how" of design and production. It is available to you for the asking. Write to the Industrial Sales Dept. MP-5.

CORNING GLASS WORKS
CORNING, NEW YORK


Fuse Plugs

Pyrex Skillet

Mixing Bowls for Hamilton Beach Food Mixer

Iced Tea Urn
made by Cecil Manufacturing Company

Vacuum Coffeemaker

CORNING means Research in Glass

INDUSTRIAL GLASS by CORNING

"PYREX" and "CORNING" ARE REGISTERED TRADE MARKS AND INDICATE MANUFACTURE BY CORNING GLASS WORKS, CORNING, N.Y.

INDUSTRIAL SALES DEPT., MP-5.
Corning Glass Works, Corning, New York

Please send me a copy of your Bulletin IZ-1—
"Industrial Glass by Corning."

Name..... Title.....
Firm.....
Street.....
City and State.....

Light from *two* Dazors converges at the critical point of work on a precision jig boring machine (Omar Tool & Machine Co.).

With Dazor light of the desired quantity and quality directed (without waste) where needed, this operator makes her Singer sing.

The Dazor and a Remington Rand Bookkeeping Machine here team up for the speed and accuracy demanded in modern accounting.

Lighting... Individually Fitted... DAZOR ALONE *Floats!*

Pan American Airways technician overhauling a Flux Gate Compass.

YOU think of a *floating* object as something which moves, glides or drifts in any direction with effortless ease . . . a mental picture which fits perfectly the freedom of movement you find in a Dazor *Floating* Lamp.

With the Dazor you can concentrate glareless, shadowless light of high intensity on any horizontal or vertical work area. With the tips of your fingers you *float* it where needed—fit it to your seeing needs. When positioned, the lamp is firmly and automatically held in suspension by a patented enclosed spring force. It *stays put* without locking, tightening or "friction" holding. Dazor alone *floats!*

In your plant and office are vital tasks which demand fast, accurate, comfortable seeing: Drafting, design engineering, precise machining, fine assembly, inspection, tests, repairs, accounting and bookkeeping . . . where specialized Dazor lighting will help increase and improve work output —save you money.

Phone Your Dazor Distributor

. . . for any additional information desired. A better idea, ask him to demonstrate the advantages of Dazor lighting under actual working conditions. For your distributor's name, if unknown to you, write to the Dazor Manufacturing Co., 4483 Duncan Ave., St. Louis 10, Mo.

IN CANADA address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ont.

CHOICE OF 4 BASES

DAZOR *Floating* LAMPS

FLUORESCENT and INCANDESCENT

Color Says "GO AHEAD"

Color is a green light in modern design. The product designer able to use color freely finds a wider scope for his talents. When you use plastics you can use color freely as an integral part of your products.

Nixon

C/N CELLULOSE NITRATE

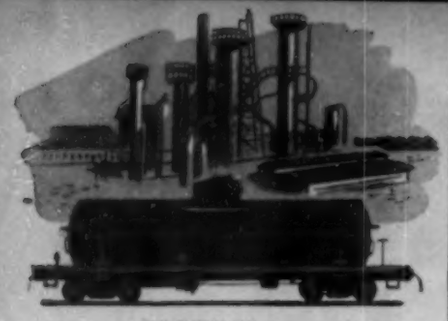
C/A CELLULOSE ACETATE

E/C ETHYL CELLULOSE

Plastics

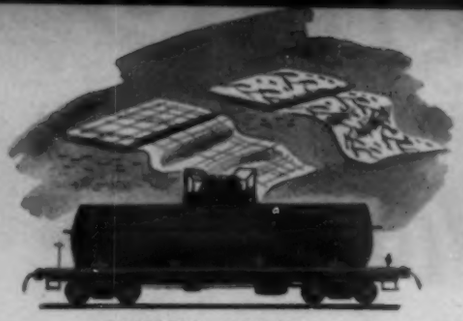
NIXON NITRATION WORKS

NIXON • NEW JERSEY



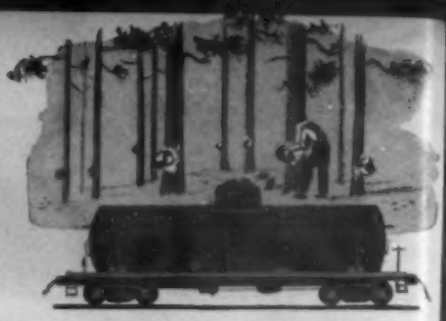
ALCOHOL

Clean, steel car, 6,000 to 10,000 gallon capacity.



CAUSTIC SODA

Heavily insulated steel car, with or without heater coils, 8,000 or 10,000 gallon capacity. Usually specially lined.

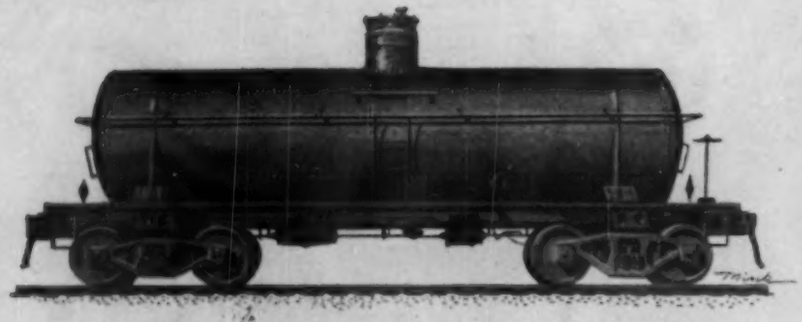


TURPENTINE

Clean steel car; 6,000 to 8,000 gallon capacity

FOR RENT

TANK CARS



Tank car transportation of liquids in bulk, pioneered by General American has proved its versatility, its efficiency, its economy.

The General American fleet comprises more than 37,000 specialized tank cars . . . 207 different types of tank cars . . . designed for the safe and swift hauling of an almost infinite variety of liquids.

General American's strategically located offices, plants, and repair shops keep these tank cars at your service; provide you with precisely the type of tank cars you want, *when* you want them, *where* you want them.

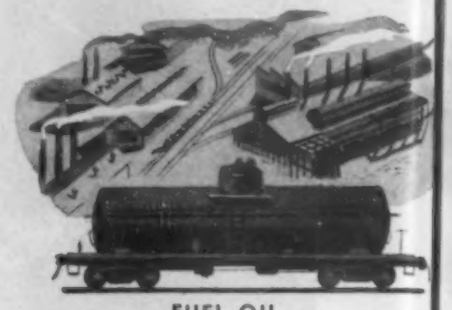
If your problem is the transportation of liquids in bulk, let the nearest General American office help you.

GENERAL AMERICAN TRANSPORTATION CORPORATION

GENERAL OFFICE: 135 South La Salle Street • Chicago 3, Illinois

DISTRICT OFFICES: New York • St. Louis • Buffalo • Seattle • Los Angeles • Dallas Houston • New Orleans • Tulsa • Cleveland • Pittsburgh

GENERAL AMERICAN TRANSPORTATION
CORPORATION
CHICAGO



FUEL OIL

Steel car, steam coiled, 8,000 to 12,500 gall capacity.

MURIATIC ACID

Car lined with pure or synthetic rubber; 8,000 10,000 gallon capacity.

GASOLINE

Clean car, 6,000 to 12,500 gallons; single or m tiple compartment

COCONUT OIL

Clean steel car, with steam coils, usually 8,000 gallon capacity.

TANNIC ACID

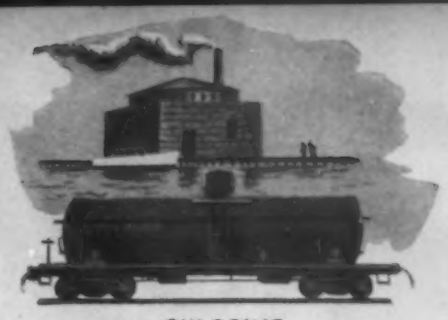
Equipped with brass coils and interior lined with a resinous, plastic or asphaltic material.

MOLASSES

Steam coiled car with heavy capacity trucks; 8,0 gallon capacity.

CORN OIL

Clean, steam coiled car.

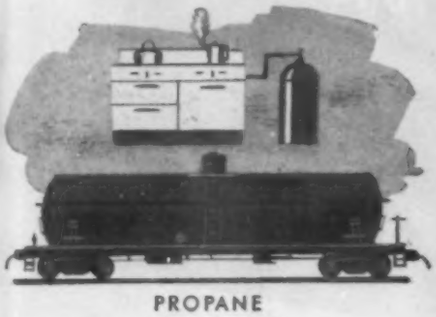


CHLORINE

Insulated, welded car; built to withstand pressure up to 500 pounds; 15 or 30 ton capacity.

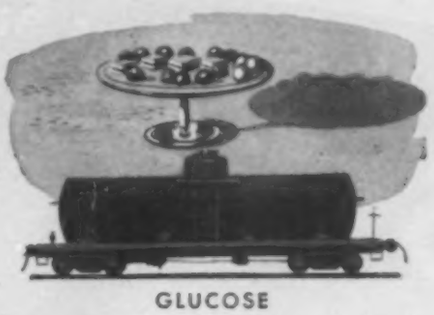
COTTONSEED OIL

Clean, steam coiled car of 8,000 gallon capacit



PROPANE

Heavily constructed car, welded and insulated. Built to withstand internal pressures to 300 pounds. Capacity 10,000 to 11,000 gallons.



GLUCOSE

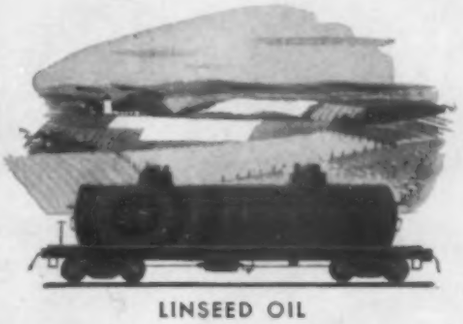
Clean, steam coiled with heavy truck capacity. Usually lined with aluminum paint.

LUBRICATING OIL

Steel car, with steam coils, single or multiple cor partment; usually 8,000 gallon capacity.

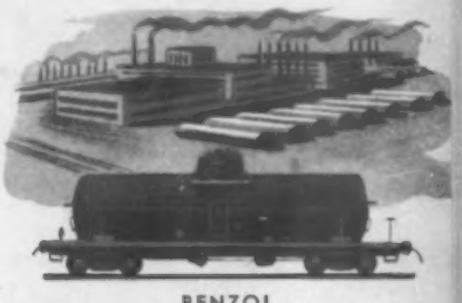
ACETIC ACID

Aluminum Car, 8,000 or 10,000 gallon capacity.



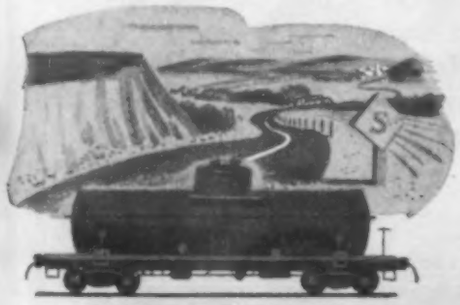
LINSEED OIL

Steel car equipped with steam coils; single or multiple compartment, usually 8,000 gallon capacity.



BENZOL

Clean car, with steam coils; 8,000 to 12,500 gallon capacity.



ASPHALT OR TAR

Heavily steam coiled car; with 2 or more inches of insulation; steam jacketed outlet; 8,000 to 10,000 gallon capacity.

LARD

Clean steam coiled car, usually of 8,000 gallon capacity

WINE

Insulated car with one to six compartments. Interior coated to preserve quality.

TUNG OIL

Steam coiled steel car, usually of 8,000 gallon capacity.

SULPHURIC ACID

Heavily constructed steel car with heavy truck capacity. Equipped to unload through dome.

FISH OIL

Steel car with steam coils.

NEVILLE

Nevillac OA Plasticizer

Specifications and Properties

Sp. Gr. @ 30° 15.6°C.	0.980 to 1.00
Viscosity (Gardner-Holdt)	W (average) @ 25°C
Distillation by volume	Essentially between 300°C and 375°C
Max. % off @ 300°C.	5%
Refractive Index @ 20°C.	1.5355
Molecular Weight	230
Odor	Sweet, Characteristic
Color	Amber
Color Retention	Good

Fields of Use

Adhesives of the waterproof, optical, shoe, packaging and pressure sensitive types;

Paper coatings both waterproof and greaseproof and for ordnance wrap;

Paints and varnishes including laminating varnishes, printing and duplicating inks;

Artificial leather and leather finishes;

Raincoats;

As a plasticizer for ethyl cellulose in lacquers, plastics and stripping compounds.

THIS new plasticizer is an alkylated phenol and has a wide range of solubilities and compatibilities. It is soluble in almost all liquids except water and glycerol. It is compatible with most synthetic resins including cellulose esters and ethers (nitrocellulose, ethylcellulose, cellulose acetate, etc.), vinyl acetate, vinyl butyral, zein, nylon, and partly compatible with vinyl acetate and chloride copolymer.

Being an alkylated phenol, Nevillac OA undergoes typical reactions. For instance, with formaldehyde, oil-soluble phenolic resins are produced which can be formulated as such in varnishes, or can be used in fortifying rosin, rosin esters, alkyd resins and established types of phenolic resins.

Write for gratis sample and further information on Nevillac OA for your particular application.

THE NEVILLE COMPANY

PITTSBURGH, 25, PA.

Chemicals for the Nation's Vital Industries

BENZOL • TOLUOL • XYLOL • TOLLAC • NEVSOL • CRUDE COAL TAR SOLVENTS
HI-FLASH SOLVENTS • COUMARONE INDENE RESINS • PHENOTHIAZINE • TAR PAINTS
RUBBER COMPOUNDING MATERIALS • WIRE ENAMEL THINNERS • DIBUTYL PHTHALATE
RECLAIMING, PLASTICIZING, NEUTRAL, CREOSOTE, AND SHINGLE STAIN OILS

A-21

"Amos did it . . . RIGHT!"

Donald Duck Camera—molded for Herbert George Co., Chicago (6), Ill.

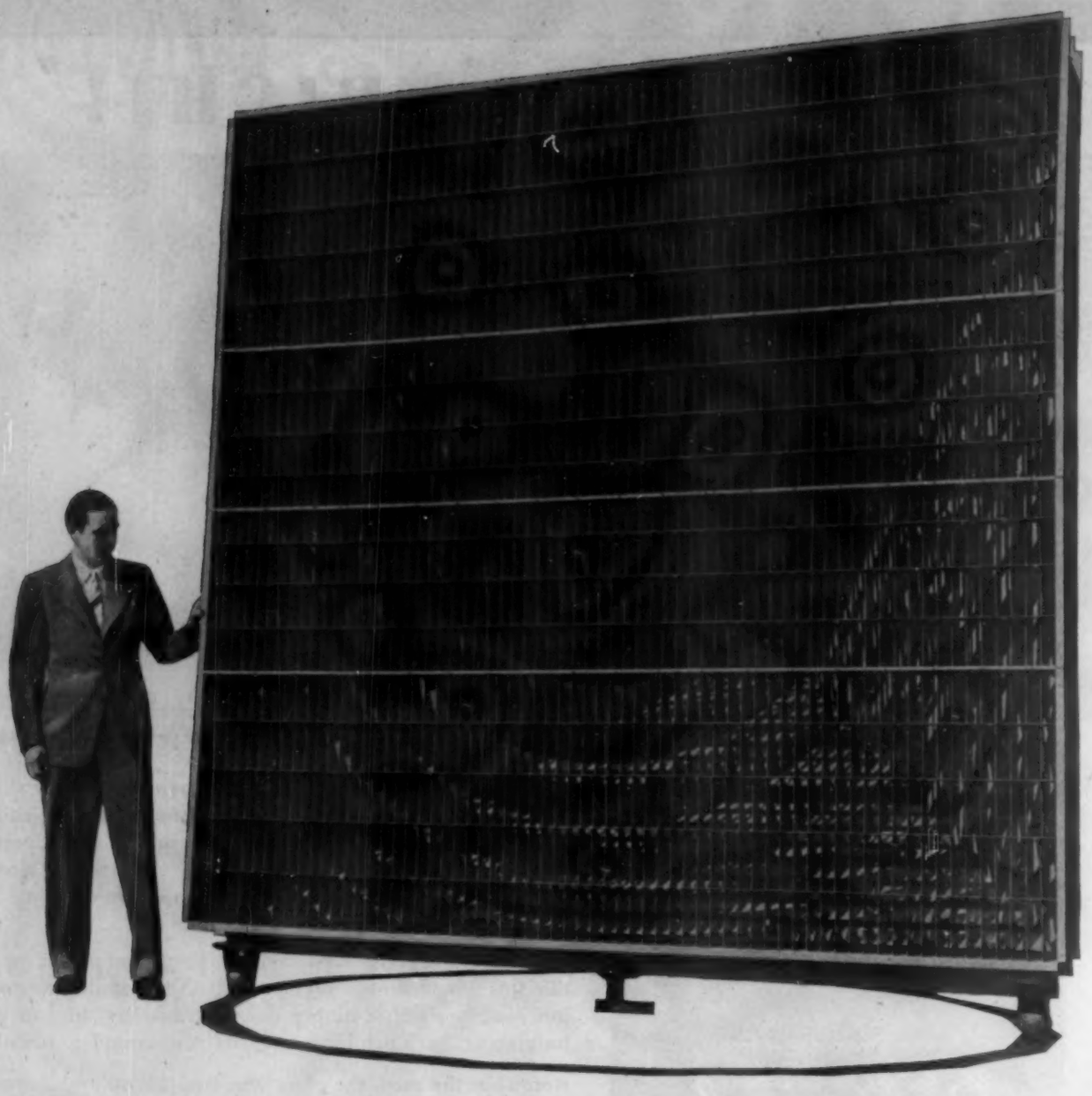
Take this little plastic camera in your hands. See how sharply accurate the molding is. There's real mold-making skill for you! See how the friction-fit back snaps on and off . . . perfectly light-tight and exact in focal-distance. Observe the clean-cut interior . . . that's close-dimension injection-molding at its very best.

Quite naturally you find yourself thinking what plastic molding like this would do for your product. Amos ability to do your job exactly right is amply demonstrated by the job you're looking at. Such production merits your complete confidence.

Amos has the men, the plant and equipment, and the experienced *know-how* to deliver fine plastic parts and products with practical economy. From engineering to finishing Amos jobs are done right! Send us your drawings—or write us about the part or product you want molded in plastics.

AMOS MOLDED PLASTICS, EDINBURGH, INDIANA

Division of Amos-Thompson Corporation



A "SEARCHLIGHT" TO FOCUS RADIO WAVES

In the new microwave radio relay system between New York and Boston, which Bell Laboratories are developing for the Bell System, giant lenses will shape and aim the wave energy as a searchlight aims a light beam.

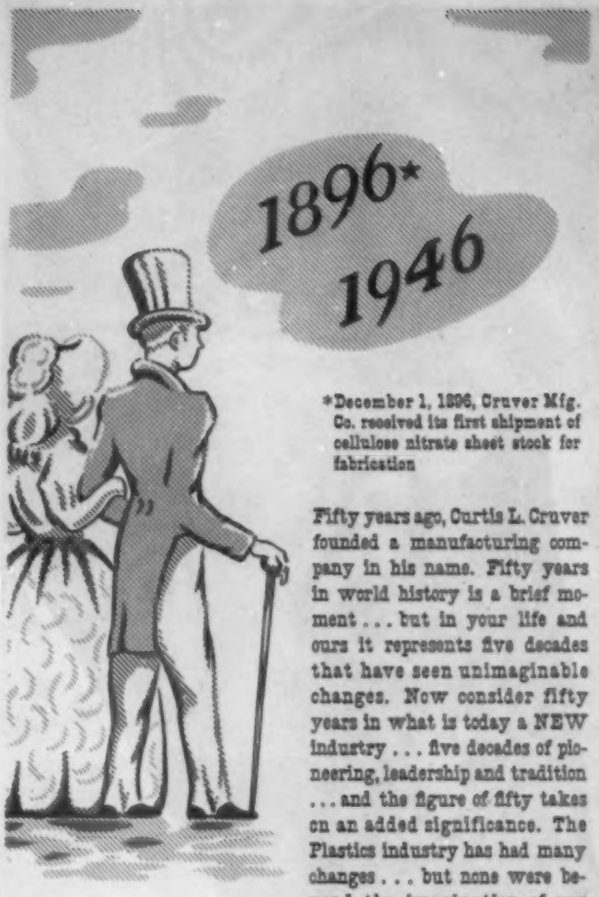
This unique lens—an array of metal plates—receives divergent waves through a waveguide in the rear. As they pass between the metal plates their direction of motion is bent inward so that the energy travels out as a nearly parallel beam. At the next relay point a similar combination of lens and waveguide, working in reverse, funnels the energy back into a repeater for amplification and retransmission.

A product of fundamental research on waveguides, metallic lenses were first developed by the Laboratories during the war to produce precise radio beams.

This "searchlight" is a milestone in many months of inquiry through the realms of physics, mathematics and electronics. But how to focus waves is only one of many problems that Bell Telephone Laboratories are working on to speed microwave transmission. The goal of this and all Bell Laboratories research is the same—to keep on making American telephone service better and better.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE



*December 1, 1896, Cruver Mfg. Co. received its first shipment of cellulose nitrate sheet stock for fabrication

Fifty years ago, Curtis L. Cruver founded a manufacturing company in his name. Fifty years in world history is a brief moment . . . but in your life and ours it represents five decades that have seen unimaginable changes. Now consider fifty years in what is today a NEW industry . . . five decades of pioneering, leadership and tradition . . . and the figure of fifty takes on an added significance. The Plastics industry has had many changes . . . but none were beyond the imagination of our Founder, Curtis L. Cruver.

The story of this organization is an adventurous tale of a man who had confidence in a dream that today is an actuality. Fifty years ago, young Curtis Cruver started working with a revolutionary material. He envisioned a multiplicity of usage coupled with ingenious production methods . . . then he backed this concrete thinking with consistent action . . . that is why today his name is synonymous with the finest in plastics.

For your product in plastic CALL ON CRUVER. Our half century of experience in designing and engineering are at your disposal. We offer assured service in molding, fabricating, laminating and printing.

50th Year in Plastics . . . . .

Cruver

MANUFACTURING COMPANY

2460 W. Jackson Blvd. Chicago 12, Ill. · Seeley 1300

NEW YORK DETROIT

TWO CHEMACO PLASTICS WORK TOGETHER

Two Chemaco plastics are used in molding this Daco-Lite battery-less flashlight. Chemaco Ethyl Cellulose forms the attractive, long wearing, practically unbreakable case, while Chemaco Cellulose Acetate is used for the brilliantly clear lens.

The Daco-lite carries its own pint-size generator and by rhythmic, gentle squeezing of the handle lights up instantly.

Let Chemaco Thermoplastics work for you. Chemaco manufactures Cellulose Acetate, Ethyl Cellulose, Polystyrene and Vinyl Compounds.

Write on your letterhead for the new Chemaco booklet containing properties charts, suggested applications and typical uses of Chemaco plastics. Address Dept. C.

Chemaco Corporation

A subsidiary of Manufacturers Chemical Corporation

Berkeley Heights, N. J.

Branch office in Cleveland

FLEXIBLE...

The flexibility of National Vulcanized Fibre, here illustrated as a barrel bung washer, is the property which makes it ideal for use where an airtight seal is required.

Resilient **Lightweight**

NATIONAL VULCANIZED FIBRE

takes the "kinks" out of tough production problems

If you need a strong, yet more flexible material to improve performance and efficiency of products or plant equipment—you're likely to get just the flexibility you want in National Vulcanized Fibre. All grades of National Vulcanized Fibre are not flexible—many are very hard, bone-like—but other grades are flexible and varying *degrees* of flexibility are available through a special treatment.

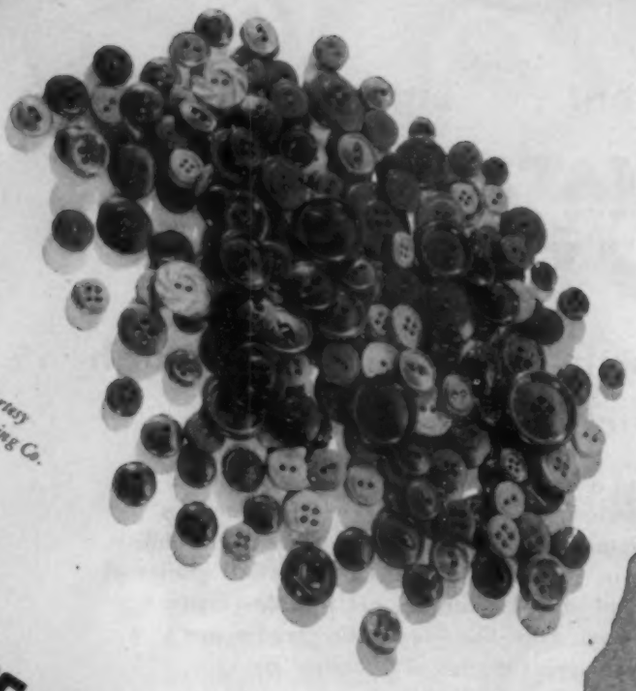
But it's the *unusual combination* of properties of National Vulcanized Fibre which may make it your answer to new, profitable products. Resilient and light in weight (about half that of aluminum), this versatile material is easily machined and formed. It has outstanding impact, tensile and dielectric strength . . . is extremely resistant to wear and abrasion . . . and is one of the strongest materials per unit weight known. Write for complete information.

NATIONAL VULCANIZED FIBRE CO.

Wilmington, Delaware — Offices in Principal Cities

DURITE

PHENOLIC PLASTICS

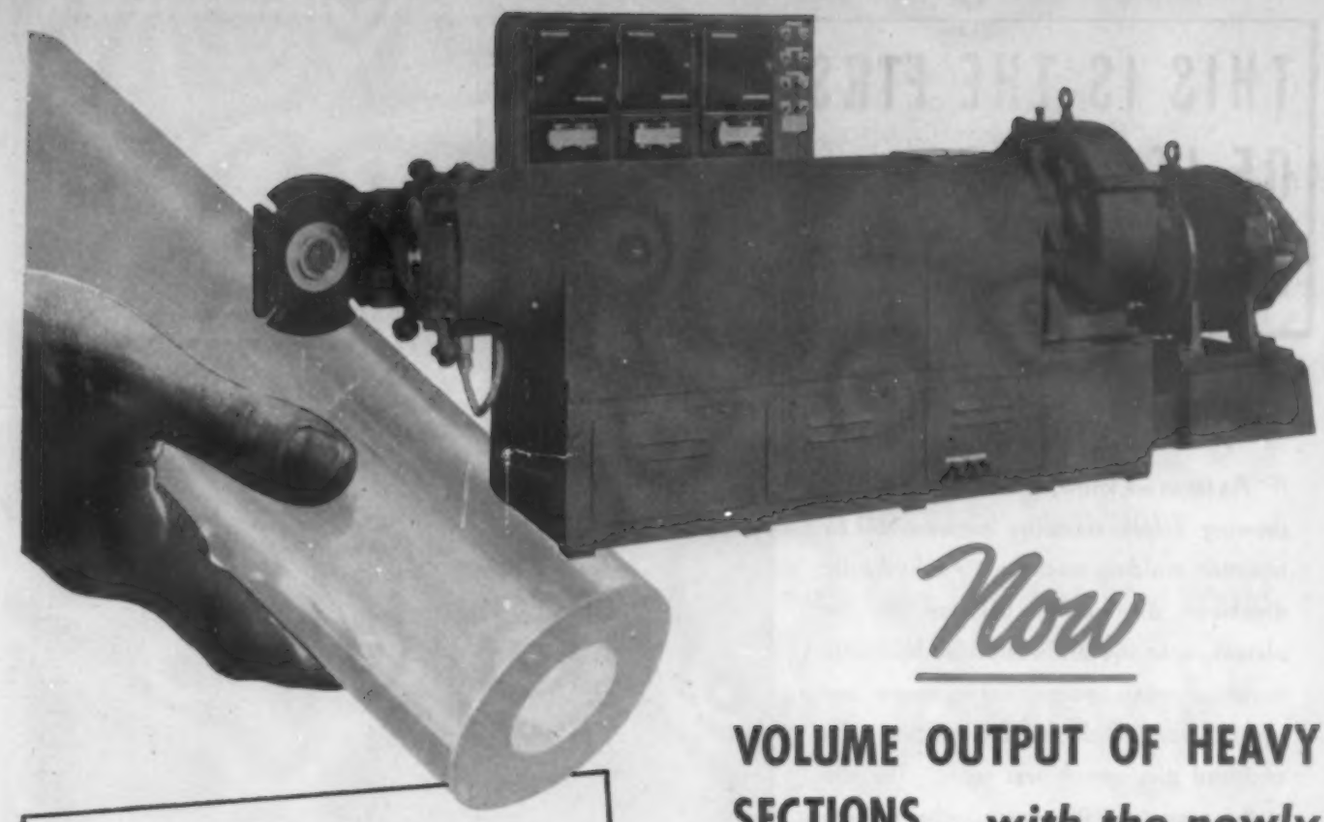


Buttons, Courtesy Emsig Manufacturing Co.

MOLDING COMPOUNDS

ADHESIVES & CEMENTS • INDUSTRIAL RESINS

DURITE PLASTICS INCORPORATED • 5000 Summerdale Ave. • Philadelphia 24, Pa.



Now

VOLUME OUTPUT OF HEAVY SECTIONS...*with the newly designed* National 4½

WANT to get volume production of the larger extruded shapes—*fast?* The newly designed 4½" National Extruder can give it to you. This machine now makes possible the successful extrusion of heavy, or large diameter cross sections which heretofore have presented difficult production problems.

And look at the many *added* advantages of producing your product by extrusion: Manufacturing costs are lowered through continuous production. Control of quality is improved. Smooth, attractive appearance is assured. Infinite variety of shapes is possible—both by extrusion itself and by stamping, punching, pressing, bending, or cutting the extruded section.

The 4½" extruder is only one of a complete line of plastic extrusion equipment for every requirement. Write for our new catalog section today.

CHECK THESE FEATURES!

1. FEED BOX—In NRM Extruders, feed box and screw function as a unit for efficient feeding. Feed box is jacketed for water cooling.
2. SCREW—The 4½" diameter screw has hard-surfaced flights. Flight characteristics and screw lengths are proportioned for complete plasticizing and high production.
3. CYLINDER—Made with a hard, corrosion-resistant liner 4½" I.D., its inner surface honed. Jacketed for sectional heating by steam or electricity.
4. DRIVE—40 H.P. variable speed motor driving through heavy duty herringbone gears, gives a range of screw speeds variable by 16 to 1.
5. BEARINGS—Roller and thrust bearings, providing high anti-friction performance.
6. HEAD—Swing type construction, permitting quick and easy replacement of screens. Head has built-in die heater, thermostatically controlled. Hinged design makes possible rapid interchange of screws.

NATIONAL RUBBER MACHINERY CO.
General Offices: Akron 11, O.

Plastics
MACHINERY DIVISION

THIS IS THE FIRST PICTURE OF ITS KIND EVER TAKEN*

* As far as we know, this is the first picture showing actual clamping pressure of an injection molding machine. An hydraulic diaphragm die was set between the die platens. Into the die was set an hydraulic gauge showing pounds of pressure per square inch. With the press closed, the enclosed photograph was made. The die in the press has 200 square inches of area on a 16-inch diameter ram. A quick calculation shows that the actual die-clamping pressure of this DEMATTIA Machine is 450 tons.

This high pressure is possible because of the press's solid frame construction which gives 96 square inches of solid steel to take up lateral stresses.

This is only one of the features which make the DEMATTIA injection press a standout for performance in plastics.

Exclusive **DEMATTIA** *Features:**

1. Actual die-clamping pressure over 400 tons.
2. Complete injection time two seconds.
3. Solid plate frame.
4. Plasticizing capacity: over 130 lbs. per hour.
5. Patented rolling action toggles non-wearing.
6. One piece welded steel base.
7. Injection pressures controlled to 30,000 lbs.
8. Hydraulic adjustment for die changes.
9. Valves, fittings, etc., mounted outside for accessibility
10. Compact, saves space—only 38 in. by 12 ft.
11. Net weight 16,000 lbs. approximately.

** Above specifications refer to 12-ounce machine*

DEMATTIA *Machine and Tool Co.*

CLIFTON, NEW JERSEY

New York Office — 50 Church Street
Cable Address: BROMACH, N. Y.

Here are Your NYLONS!

Unbreakable Tumblers

to Astonish Even this Post War World

CUSTOM MOLDED by

ERIE RESISTOR

This is the unbreakable tumbler that is taking the retail trade, and American housewives, by storm. A tumbler that can be dropped from a twenty story window, bounced against a brick wall, thrown at a stray cat, and sterilized in boiling water. Handsome, too, of glistening ivory, inside and out.

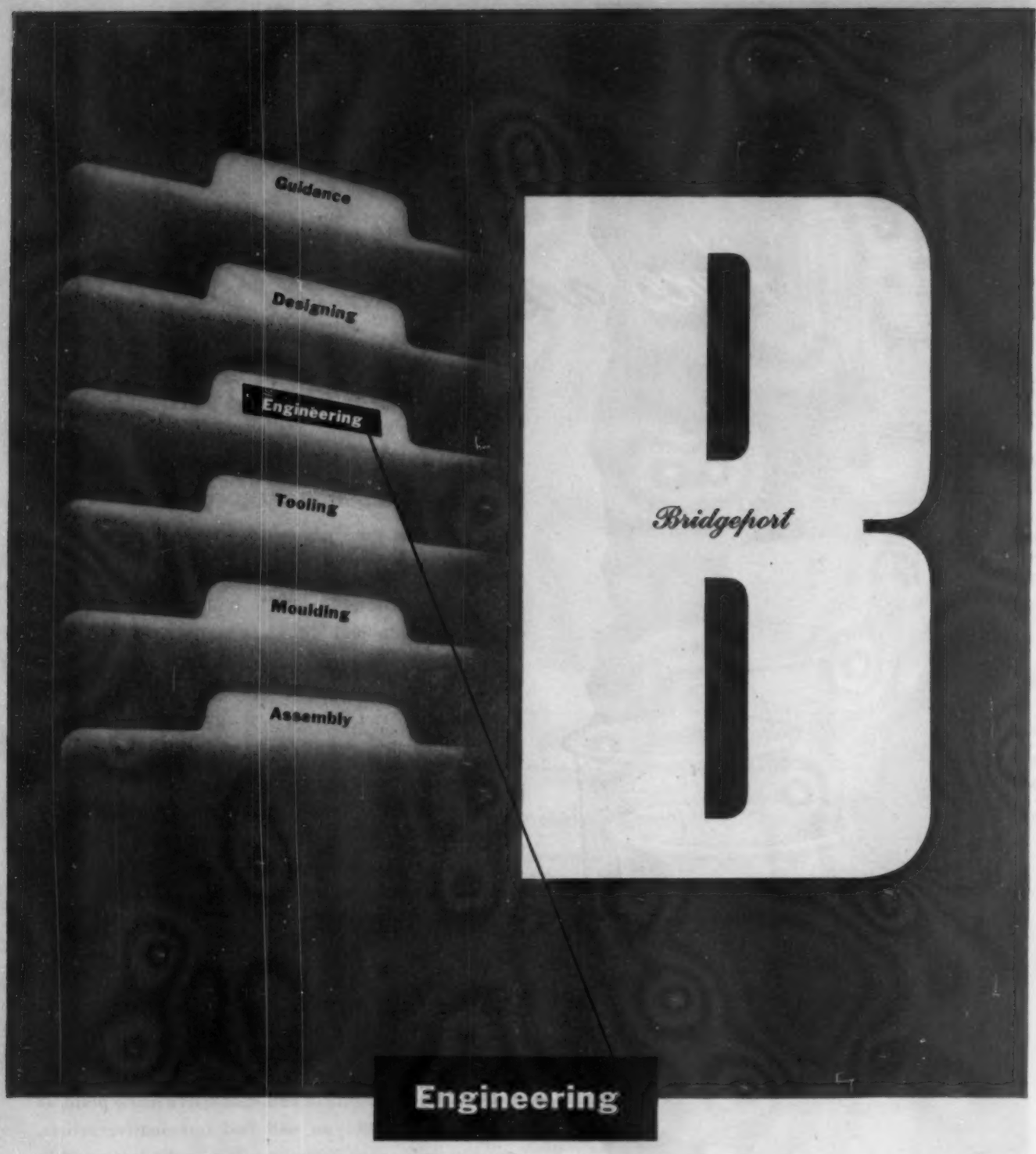
It's not suprising that DuBois Plastic Products, Inc., 37 Franklin Street, Buffalo, New York, came to ERIE RESISTOR for the first production of a Nylon tumbler. For buyers have learned that ERIE RESISTOR is capable of doing things that haven't been done before; jobs that must season past experience with a new ingenuity. In this case, ERIE RESISTOR used the largest shot of Nylon ever attempted in injection molding.

Whether the plastic product that you need is an article for the trade, a part for your own complete assembly, or a beautiful and distinctive name plate, at ERIE RESISTOR you will find imaginative artists, creative engineers, skilled operators, the last word in equipment, and a spirit of cooperation that you can't beat anywhere.

Plastics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • TORONTO, CANADA



In this vital phase we offer you careful planning from original design to finished product. We are staffed to engineer your most complicated plastics problem, whether it be a small part or a complete unit . . . . For plastics, think of Bridgeport.

BRIDGEPORT MOULDED PRODUCTS, INCORPORATED

BRIDGEPORT B CONNECTICUT

PURE

UNIFORM STRENGTH

WATER WHITE

LOW IN ACID

LOW METAL CONTENT

DU PONT

FORMALDEHYDE

U. S. P. SOLUTION

DU PONT FORMALDEHYDE is designed to meet the high requirements of the plastic industry. It's completely dependable—produced under controlled conditions to assure you consistently fine raw material.

READY FOR IMMEDIATE SHIPMENT in the quantity you need. Shipments are made in standard containers from the factory or stocks maintained in principal cities.

DEPEND ON DU PONT also for: ***Paraformaldehyde*** —95% minimum strength. And ***Hexamethylenetetramine*** —U. S. P. crystals or technical. For additional information and technical assistance, call our nearest office. Electrochemicals Department, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Cincinnati, Dallas,* Detroit, El Monte, Houston,* Kansas City,* New York, New Orleans,* Oklahoma City,* Philadelphia, Pittsburgh, San Francisco, Tulsa,* Wichita.*

**Barada & Page, Inc.*

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING

. . . THROUGH CHEMISTRY

DU PONT ELECTROCHEMICALS

Looking for Allover Improvement?

Try Plastics molded with Heatronics

This radio housing is a shining example of what you can accomplish with Heatronics (radiofrequency pre-heating). Molded conventionally, it was formerly produced in a 200 ton press.

Now, with the higher plasticity and easier flow Heatronics gives us, we use only 150 tons of pressure. Result: a piece with better cure, uniform density, better mold finish, less internal stress, and every strength factor materially increased.

Complete information on Heatronic molding and what it can do for *you* is readily available here at Kurz-Kasch—and so is a complete custom molding service specializing in compression and transfer molding.

We're physically equipped to handle every detail of your job under one roof. With this plant capacity goes experience going back to the birth of the plastics industry—a solid foundation on which to build today's improvements.

We're specially qualified to talk Heatronic molding with you too, since we pioneered Heatronic techniques in plastics. Just put any or all of your questions about plastics up to a Kurz-Kasch engineer!

Kurz-Kasch

For Over 29 Years Planners and Molders in Plastics

Kurz-Kasch, Inc., 1415 South Broadway, Dayton 1, Ohio. *Branch Sales Offices:* New York • Chicago • Detroit
Los Angeles • Dallas • St. Louis • Toronto, Canada. *Export Offices:* 89 Broad Street, New York City

"Hey Fellow, I'm no racehorse"

Race-horse *lightness* with truck-horse *strength?* Nature isn't asked to produce such "don't-go-together" combinations. But KYS-ITE is—and does. Knowing that, engineers turn our way when plans call for one material combining *all* the properties shown below. Look them over and see how KYS-ITE fits into your production picture, too.

GREAT STRENGTH WITH LIGHT WEIGHT — Preformed before curing, an even distribution of phenolic resin on interlocking fibres results in great tensile and compressive strength and with an impact strength up to 5 times that of ordinary plastics.

WIDE RANGE OF SHAPES—Complicated pieces with projections and depressions, large or small shapes and sections—all these and more, too, are molded successfully in KYS-ITE.

KYS-ITE CAN "TAKE IT"—Unusually durable and resistant to abrasion, impervious to mild alkali and acid solutions.

INTEGRAL COLOR—KYS-ITE's lustrous finish is highly durable; the color is an integral part of the material itself. A wipe and it's bright!

NON-CONDUCTOR—KYS-ITE's dielectric properties make it invaluable where safety is a factor. Also a non-conductor of heat. Non-resonant and non-reverberating.

DEMAND FOR KYS-ITE has been so heavy that we cannot handle further specialty orders at the moment. With materials and manpower becoming more available, this situation is improving, however. Before long we hope to be ready for new business.

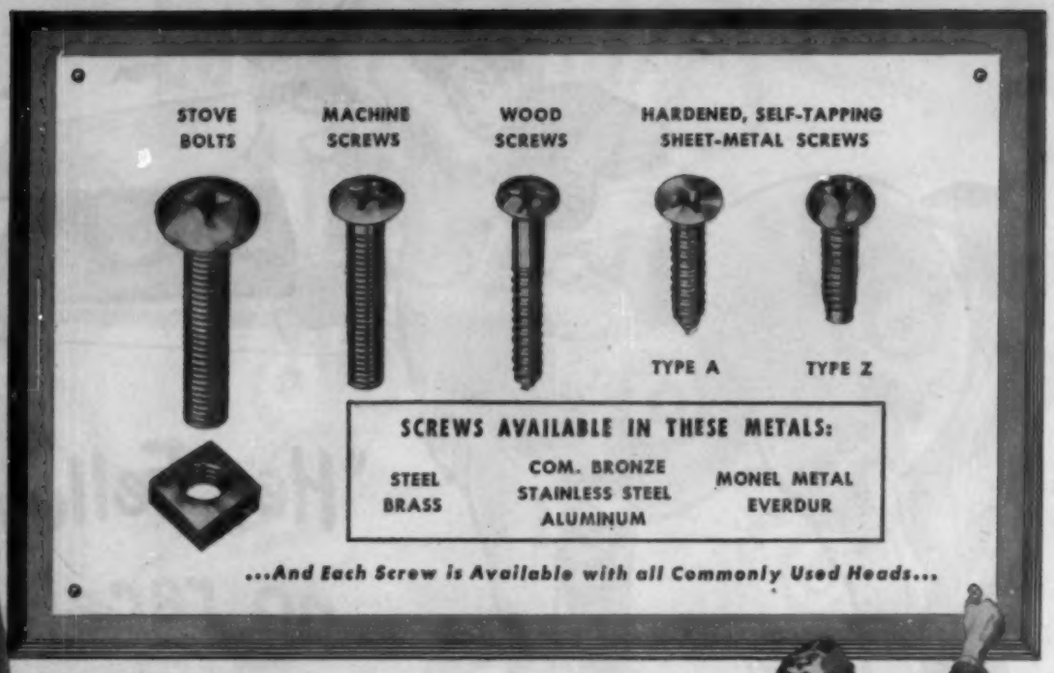
KEYES FIBRE COMPANY
420 Lexington Avenue
New York 17, New York
Plant at Waterville, Maine

KEYES
MOLDED PRODUCTS

KYS-ITE articles indicating the range of items we mold to specifications and deliver complete, ready for use.

Preformed Plastic Combining Long- **KYS-ITE*** **Fibred Wood Pulp and Synthetic Resin**

*Trademark Reg. U. S. Pat. Off.



You can get the SPECIAL SAVINGS of AMERICAN PHILLIPS SCREWS in any type...with any head...in any metal

No other screw-driving method can give you the time-savings of American Phillips Screws—*as much as 50% under your present assembly time.* American Phillips Screws give you the self-aligned fit between screw and bit . . . the fumble-proof ease of driving . . . the slash-proof protection for work surfaces . . . and the value-protection for *you* that comes from American's quality-control and 4-phase inspection, assuring higher perfection-percentage in every order marked "*American brand.*"

And nowhere can you find a more complete line, especially in the range of *rust-resistant metals* . . . aluminum, monel, everdur, and particularly stainless steel. American specializes in Phillips Screws of stainless steels in many different analyses, according to specifications dictated by different uses. So make use of American's unrivalled experience and know-how in metallurgical research. Write today for advice on American Phillips Screws of the type and metal that will do the best job on your fastening problem . . . and the best job of cutting your assembly costs to a new low.

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

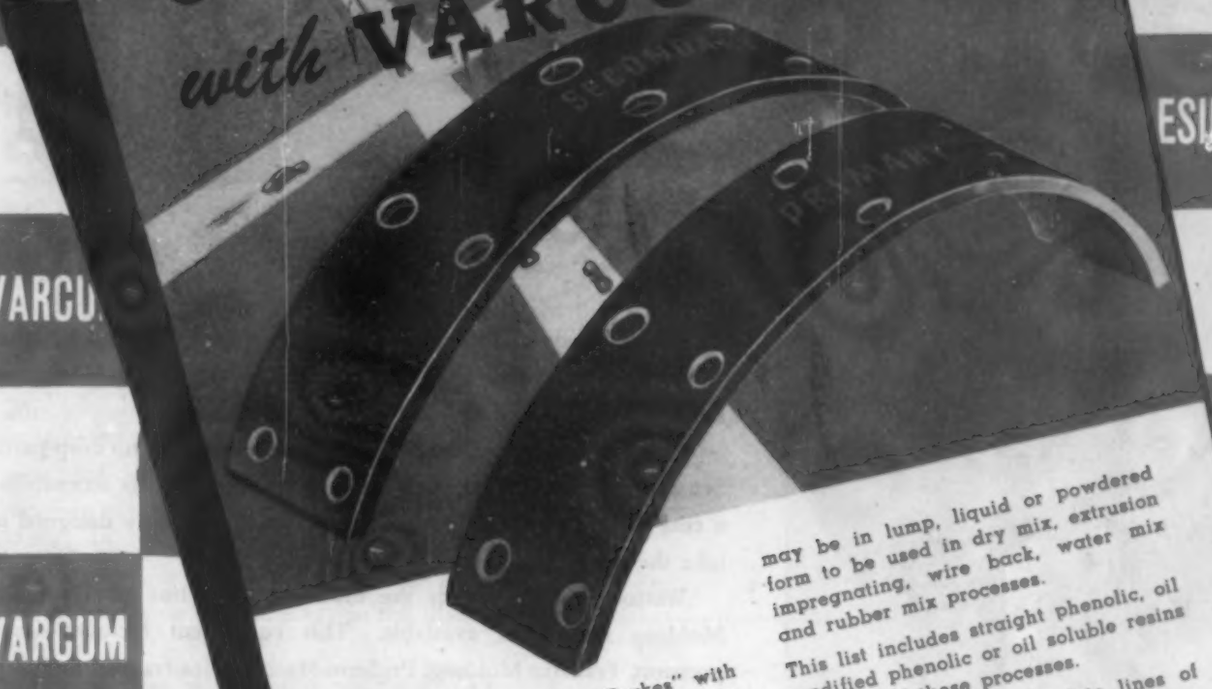
Chicago 11: 389 E. Illinois Street *Detroit 2:* 502 Stephenson Building

You've got Thousands to Gain—and Nothing to Lose
WHEN YOU CHANGE TO:

AMERICAN PHILLIPS *Screws*

VARCUM PHENOL CH_2O RESINS

GET THE "BRAKES" with VARCUM resins!



WHEN you get the "Brakes" with VARCUM resins, you also get "the breaks".

We manufacture a complete line of resins for friction materials.

This includes resins for automobile, truck and industrial linings as well as resins for brake blocks. The resins may be in lump, liquid or powdered form to be used in dry mix, extrusion impregnating, wire back, water mix and rubber mix processes.

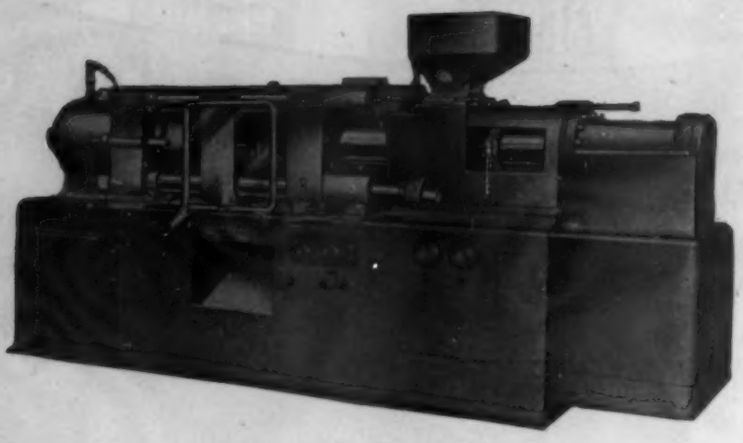
This list includes straight phenolic, oil modified phenolic or oil soluble resins for most of these processes.

VARCUM also has complete lines of phenolic resins for many other applications and we solicit your inquiries for custom made resins to fit your specific requirements.

VARCUM
CHEMICAL CORPORATION
NIAGARA FALLS • NEW YORK

the New WATSON-STILLMAN

INJECTION MOLDING MACHINE



Horizontal Injection Molding Machine

The same sturdy quality design—with more flexibility and a higher degree of control. That's the new line of Watson-Stillman Horizontal Injection Molding Machines.

Increased stroke and opening for the molding of extra deep parts. Sensitive controls to meet any molding condition. Easy accessibility a real feature. These machines have been particularly designed to take the kinks out of molding problems.

Watson-Stillman builds the most complete line of Hydraulic Molding equipment available. This equipment includes Compression, Transfer Molding, Preform Machines for transfer molding, Vertical and Horizontal Injection Machines, all in a wide range of capacities. In addition, Watson-Stillman also manufactures a complete line of Hobbing Presses in sizes from 200 to 3000 tons.

Let our Plastic Engineers go over your particular molding problem with you. Write or call—Watson-Stillman Co., Roselle, N. J.

1038

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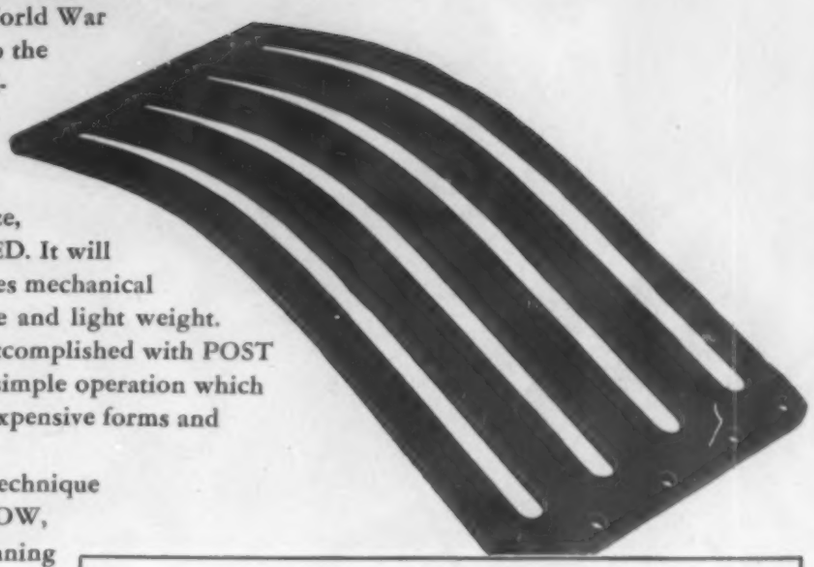
NEW PROBLEMS?

C-D has developed New Techniques to help you better utilize

LAMINATED PLASTICS

Forming of finished laminated thermosetting plastic sheets came into prominence during World War II to meet certain product needs vital to the war effort. NOW this technique is available to you to help you solve your present "What Material?" problems.

Pictured is a laminated canvas base C-D DILECTO part. It was sawed to size, drilled, milled, slotted . . . then FORMED. It will permanently retain its shape. It combines mechanical and electrical properties with resilience and light weight. Much more intricate forms are easily accomplished with POST FORMING Dilecto stock. It is a fairly simple operation which can be done in your own shop with inexpensive forms and heating equipment.



You should learn all about this new technique in the forming of laminated plastics, NOW, while your new products are in the planning stage.

Phone, wire or write our nearest office to arrange for a call from a C-D technician.

C-D PRODUCTS

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DILECTO—Thermosetting Laminates.
CELORON—A Molded Phenolic.
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DIAMOND Vulcanized FIBRE
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Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

Descriptive Literature

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

RKC-46

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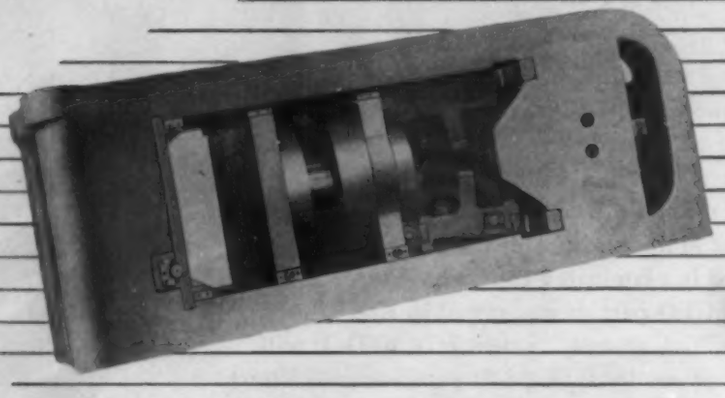
SEE OUR CATALOG IN SWEET'S

Continental-Diamond FIBRE COMPANY

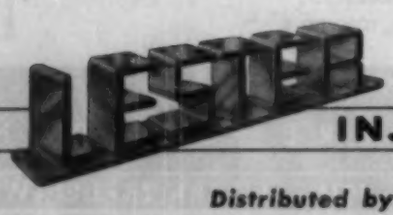
Established 1895. . Manufacturers of Laminated Plastics since 1911—NEWARK 28 • DELAWARE

INJECTION MOLDING



TAKES A STEP FORWARD

No injection molding machine is any better than the locking and holding power of its frame. High injection pressures, to have maximum effect upon the material injected, must be confined strictly to the mold cavities. That's why Lesters are now built with solid, one-piece cast steel frames, eliminating any possibility of stretch or weaving in the frame itself. The new and larger central mold support, combined with a simplified toggle mechanism, provide a solid metal-to-metal column which offers mold locking pressure conservatively rated at 600 tons in the larger machines, as well as constant and absolute parallelism of the mold platens. The result: dense, structurally stable, extremely accurate, flash-free moldings twenty-four hours a day. Any molder can make better moldings with a Lester. Write for full details.



INJECTION MOLDING MACHINES

Distributed by **LESTER-PHOENIX, INC.**

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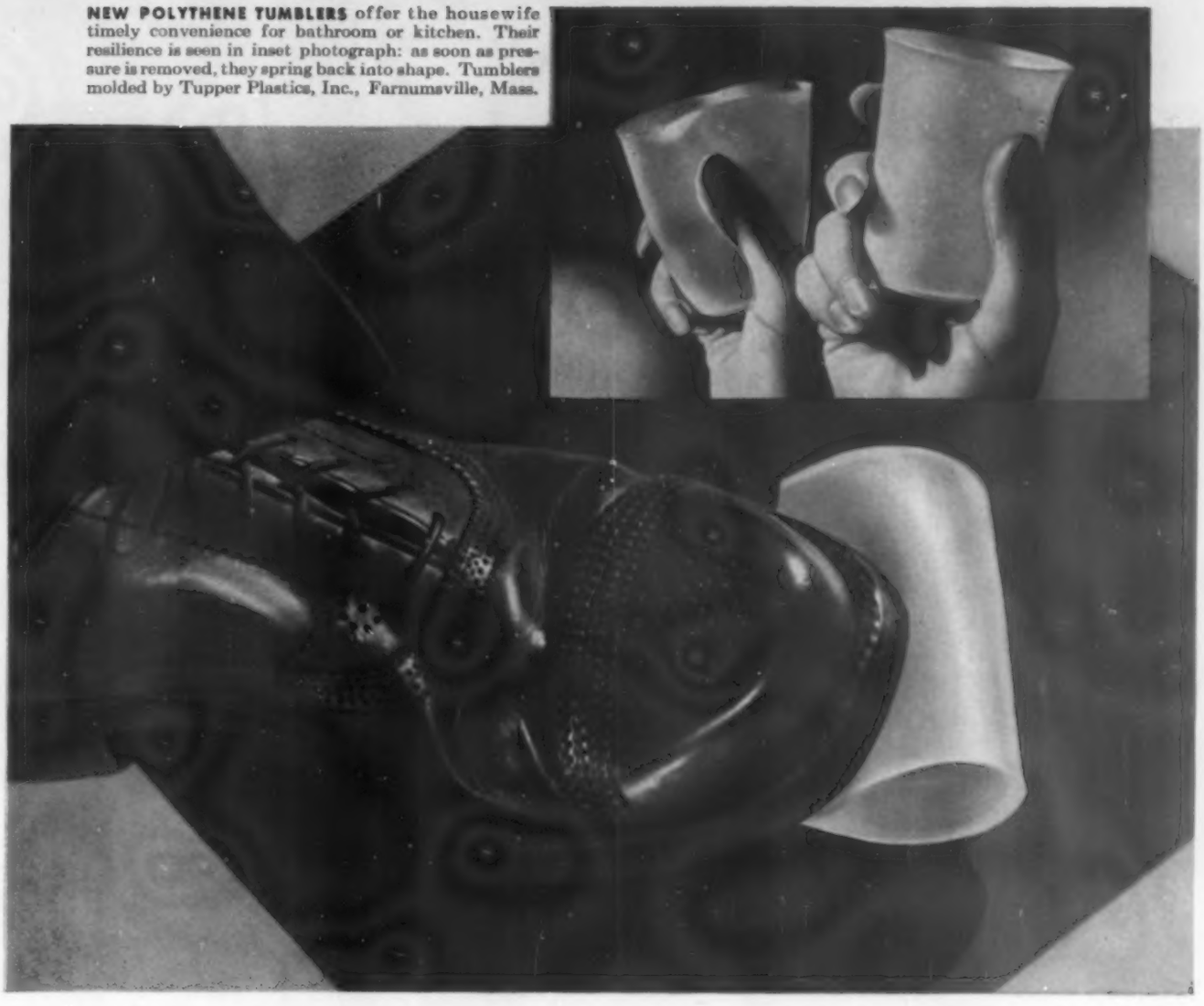
NEW POLYTHENE TUMBLERS offer the housewife timely convenience for bathroom or kitchen. Their resilience is seen in inset photograph: as soon as pressure is removed, they spring back into shape. Tumblers molded by Tupper Plastics, Inc., Farnumsville, Mass.



TUMBLERS THAT MAKE LIGHT OF A HEAVY FOOT

Made of Du Pont polythene . . . they're unbreakable!

CHOOSE YOUR COLOR!
Polythene molding powder is made in a wide range of attractive colors. For tumblers, as for many other products, color helps to make the finished product more salable.

Another new product from a Du Pont plastic! These household tumblers are also light, tasteless, odorless, good-looking—just what the housewife has been looking for, for years.

An alert manufacturer saw in the unrivaled properties of Du Pont polythene just the combination for the product he had planned. The specific gravity of polythene is 0.92. It floats on water! Polythene is chemically inert, flexible, and has outstanding electrical properties too. Other manufacturers are using many of these properties to advantage in products as diverse as refrigerator bowl covers, insulation for television cables and—baby pants.

We think it will pay you to know more about polythene—and about all the other Du Pont plastics too. One of them may lead you to a new product or a way to improve an older one. Why not write for literature on them all—today? E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., Room 365 Arlington, New Jersey.

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Apparent to the knowing eye is the craftsmanship that identifies the work of the master painter. Columbia—working in the modern medium of colorful plastics—likewise evidences that touch of genius which marks the true artist.

Columbia plastic combs, miracles of beauty and utility, are but one of many masterpieces produced by Columbia for the millions . . . by the million.

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INDEPENDENT INVESTIGATOR FINDS

BENDIX HOME APPLIANCES, Inc.

3 enlists 3 advantages of Phillips Screws to make BIG ASSEMBLY SAVINGS

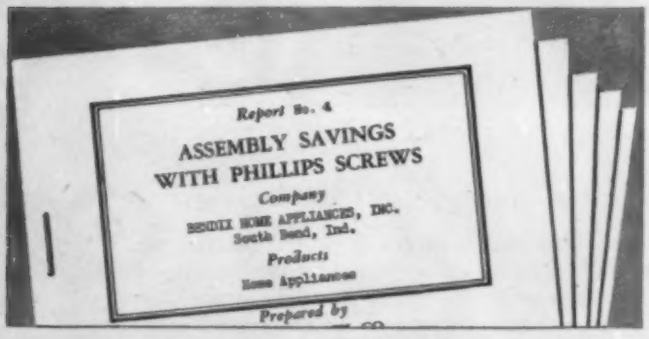
This investigator from James O. Peck Co., industrial research authorities, is visiting representative plants to get unbiased facts on assembly savings. Get his fact-filled reports!

"THEY'RE MUCH, MUCH FASTER by every driving test," Harry L. Spencer, Bendix V. P. in charge of manufacturing, told the investigator. "Since we'll use well over 19,000,000 Phillips Screws this year on washer production alone, that means an important saving.

"EVERY DRIVER SKID WE AVOID (and we'd have *plenty* with slotted screws) saves us 50c to $5.00, according to the extent of the damage, for disassembly, refinishing, and re-assembly. That's another reason why we are sold on Phillips."

"UNSIGHTLY SLOTS with burrs to snag clothes just couldn't be tolerated on a washer. We get no burrs with the Phillips Head – and it looks well, wherever it shows."

These highlights from the complete report on Bendix assembly savings point up economies you can't afford to ignore with today's squeeze on profits. This report, together with others now ready, and more to come, make up a practical manual of successful assembly practice, inside facts you can get now, FREE.



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Please send me the reports on Assembly Savings with Phillips Screws

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Company .....

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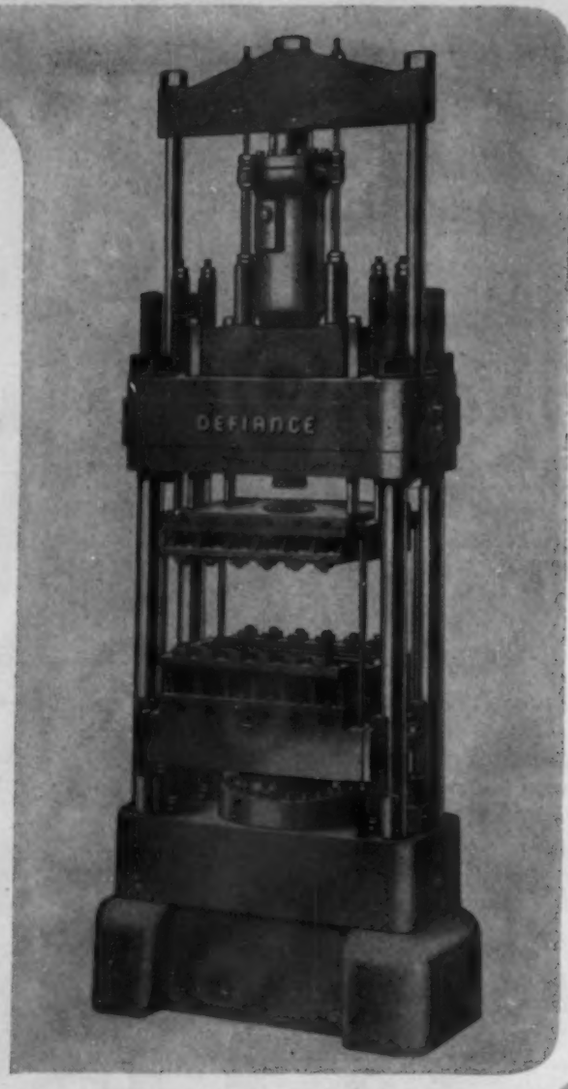
A TRANSFER PRESS FOR QUALITY MOLDING



Quality plastic products are readily turned out by the Transfer molding process. The Defiance Machine Works No. 152 Transfer Press, shown in the illustration, permits utilization of the many specific advantages of Transfer molding.

In this press the mold charge is brought to a soft plastic condition by electronic heating in the transfer chamber, located in the floating platen. Designed for use with a variety of molds, the transfer chamber is straight bore, open at both ends and self-sealing. It is not bolted or fastened to the mold.

An electrically heated transfer plunger, mounted on the upper platen, transfers the charge into the mold through a single opening. Heat and pressure are applied to the mold and complete cure takes place. The press is designed for standardized Transfer molds of simplified design.

Advantages to the molder who uses Transfer molding include greater economy, improved appearance and uniform strength of products. You can safely and accurately produce plastic parts with delicate inserts, thin-walled holes and variable walls for longer and faster production runs by using the Transfer molding process.

SHAW

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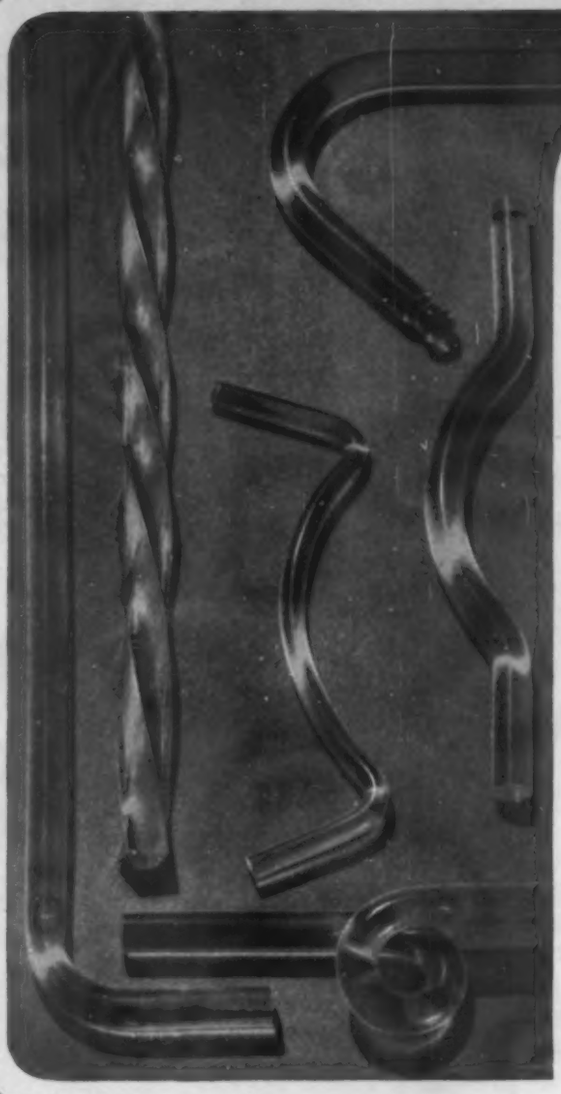
160 COIT STREET — QUALITY MARK ON MOLDED PLASTICS — IRVINGTON 11, N. J.

TRANSFER MOLDING LITERATURE AVAILABLE

If plastics are called for in your production plans, you will want to investigate Transfer molding—and you will want your engineers and designers to work closely with your molder. A list of licensed Transfer molding companies near you will be sent promptly upon receipt of your request. Choose one and work with him.

Meanwhile you may want to learn more about Transfer molding advantages. We have numerous bulletins and technical articles available for you. And between the resources of Shaw and Plax Corporation, Hartford 5, Conn., you can obtain specific assistance in most plastic methods and materials. Write either company for such help.

HOW TO FORM PLAX POLYSTYRENE ROD



Plax crystal polished polystyrene rod can be heat formed without difficulty into many shapes and intricate bends. Correct forming techniques should be closely observed.

Any conventional heating method may be used. Either a liquid bath or a circulating air oven, at 250°F. to 265°F., is satisfactory. Actual heating time depends on rod diameter. A few simple preliminary timing tests should provide data for use on a production basis, using the table shown below as a guide.

Well sanded and polished hardwood forms serve the purpose of maintaining correct shape until the bend has cooled sufficiently. Preheated forms are even better because polystyrene must be cooled slowly to prevent thermal shock and subsequent crazing due to sudden chilling. The best temperature for a preheated form is about 165°F.

Wiping bent sections after cooling, with an emuslified water-base wax, will restore their original high lustre. Any surface blemish on the finished shape can be removed by buffing.

If possible, machining operations should be performed prior to forming. When necessary to machine after forming, Plax machining instructions should be carefully followed. These instructions call attention to the fact that petroleum base materials, such as oil and kerosene, are deleterious to polystyrene. They name proper coolants and give other helpful information.

Heating Time Guide

Rod Diameter	*Time*	
1/4"	5–7 min.	250°- 265°F.
1/2"	15–18 min.	
3/4"	18–20 min.	
1"	22–25 min.	
2"	35–40 min.	

OTHER POLYSTYRENE DATA AVAILABLE

Bulletins on how to machine, what to tell machinists, how to use coolants and how to cement — all on Plax Polystyrene products — are available on request, along with information on standard and special forms of polystyrene offered by Plax.

Literature is also available on Plax Cellulose Acetate, Cellulose Acetate Butyrate, Methacrylate, Polyethylene and other products — including one on plastic bottles. Engineering help covering nearly all plastics materials and methods is available from Plax and the Shaw Insulator Company, Irvington 11, N. J. For literature mentioned above . . . write Plax.

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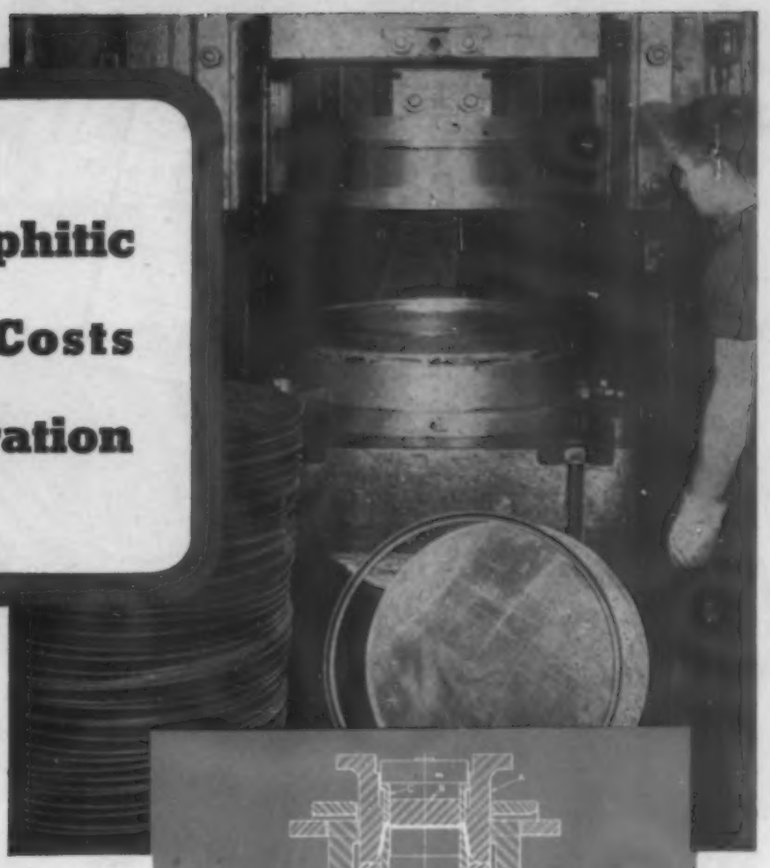
How Timken Graphitic Steel Reduced Costs 25% on This Operation



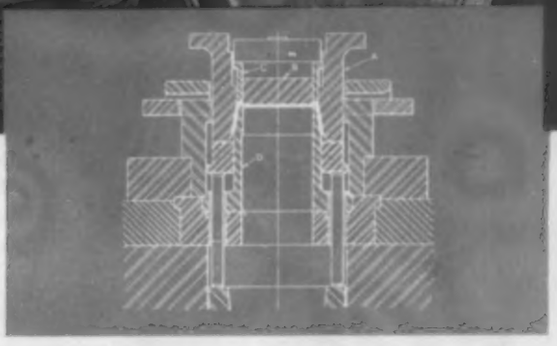
Even large size cage blanks for roller bearings are formed in a single operation at The Timken Roller Bearing Company. A 600-ton press is used to perform this operation from strip .187 inches thick.

Blanks pictured here are 28.750 inches in diameter and require a draw 1½ inches deep. Bottom of cage is 24½ inches in diameter and is punched out without any shear on punch or die. The slug comes out flat and can be used for another caged blank of smaller diameter.

Use of Graph-Mo Steel, one of the 5 Timken Graphitic Steels, in 6 vital parts of this die has brought a saving of *25% in cost!*

This is but one of the more than 400 applications in the plants of The Timken Roller Bearing Company where Timken Graphitic Steels have proved superior to all others.

As both a *major producer* and *major user* of fine tool and die steels, the Timken Roller Bearing is in a unique position, not only to meet your requirements, but also to supply valuable performance-proved data from its own plant.



If you don't have a copy of our 48-page book — "Timken Graphitic Steels", write for a copy today. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

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Fine Alloy
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Electronics

The case for Dielectric Heating

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

hikes production 1/3...cuts mold size 4/5

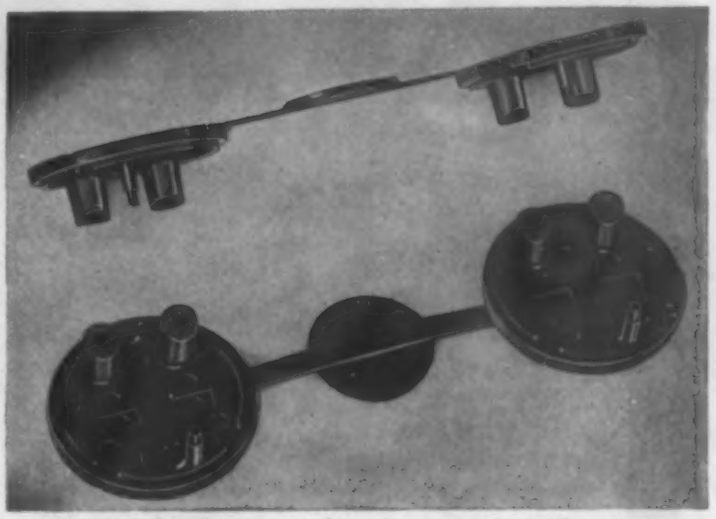
When you can whittle the over-all time cycle for molding thermosetting plastics by 36%, obtain a better product and reduce the costs of all phases of the operation, you've gained an effective new tool for modern production. Here is a typical case study showing how you can improve your production.

Meter box covers formerly molded by compression in a 9-cavity mold required a total cycle time of 5.42 minutes. Now they are produced in a 2-cavity "Hy-Speed" plunger press—with radio frequency (dielectric) preheating—in 46 seconds total cycle time, which includes cure as well as press loading and unloading time.

And dielectric preheating makes it possible to mold these meter box covers with long, slender holes which eliminate the jig drilling operation previously required. So successful is this new system that one manufacturing plant using dielectric preheating saved more than 66% of their previous mold costs alone!

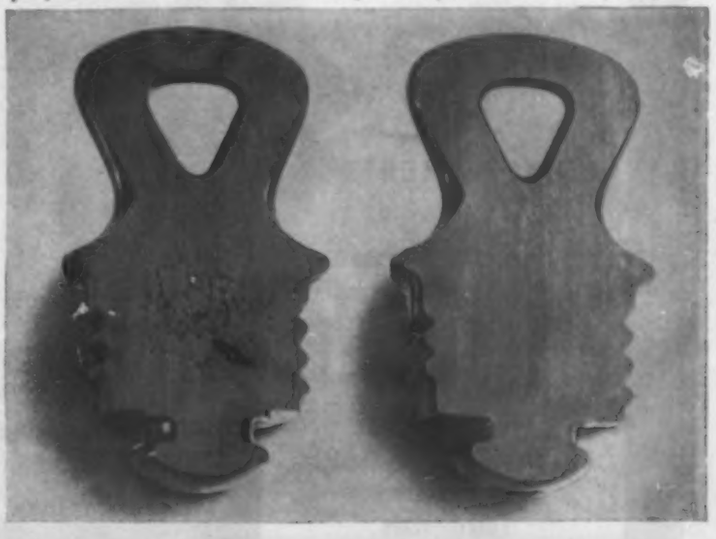
This exceptional versatility and effectiveness of dielectric heating is nothing new to plastic manufacturers familiar with the broad background of Westinghouse in helping radio frequency heating to new achievements. Get all the facts today from your nearest Westinghouse office. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-08168



Cycle time for these meter box covers was cut 36 percent.

Hot-water bottle stoppers like these were molded 1/3 faster with a mold size 1/5 of previous compression mold and with uniform polymerization of the material (old way, left; new way, right).



Electronics at Work

Here's Helpful Information

on both induction and dielectric heating . . . their principles and theories; where to use them; how to select them; actual case histories of their use. Write today for your copy, on your business letterhead, please. Ask for B-3620.

POWER-DRIVE SMALL SCREWS *Fast!*

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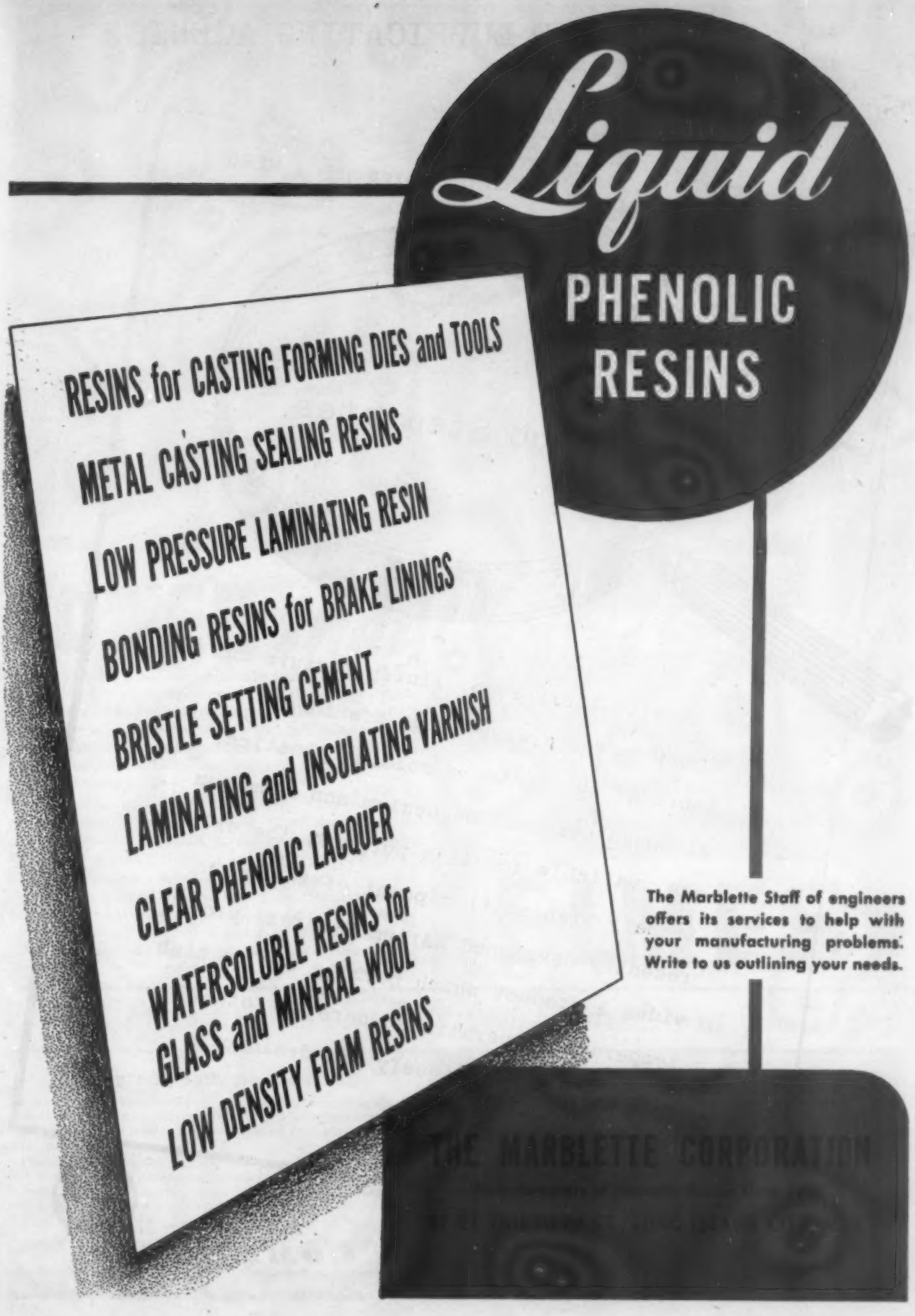
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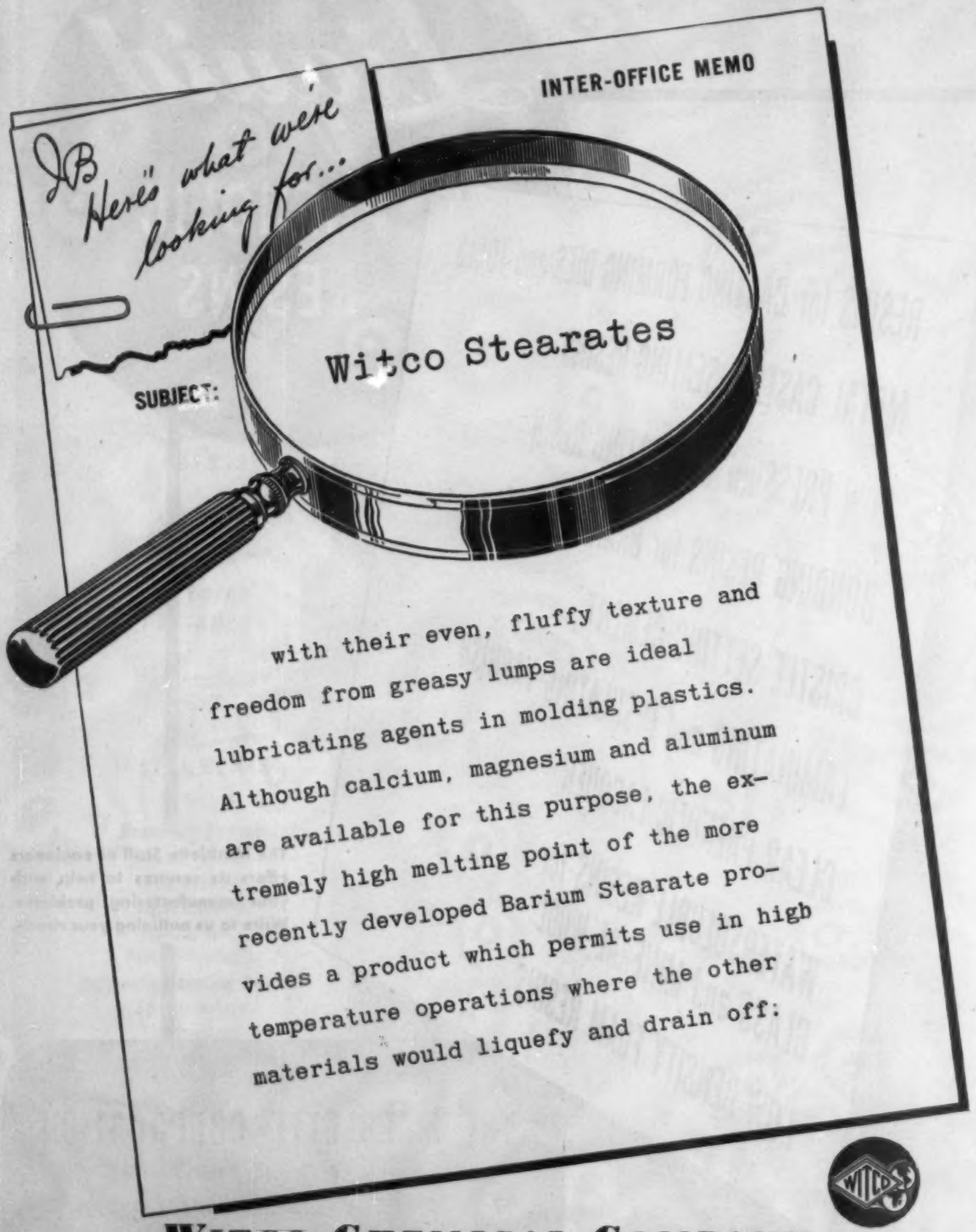
GLASS and MINERAL WOOL
LOW DENSITY FOAM RESINS
The Marblette Staff of engineers offers its services to help with your manufacturing problems. Write to us outlining your needs.
THE MARBLETTE CORPORATION

"...IDEAL MOLD LUBRICATING AGENTS"



with their even, fluffy texture and freedom from greasy lumps are ideal lubricating agents in molding plastics. Although calcium, magnesium and aluminum are available for this purpose, the extremely high melting point of the more recently developed Barium Stearate provides a product which permits use in high temperature operations where the other materials would liquefy and drain off.

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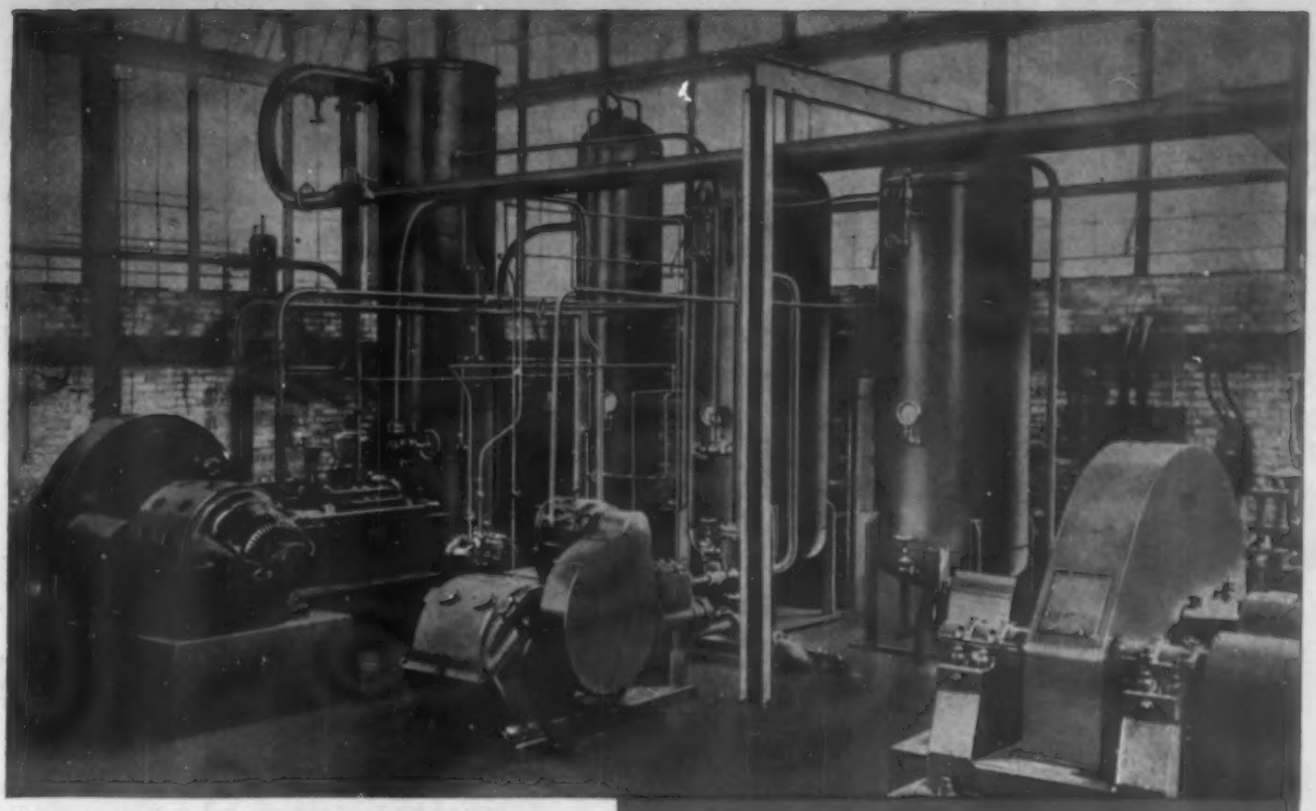

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Please ask us, too, for Bulletin No. 1020, "Elmes High-Pressure Pumps." These dependable sources of fluid power are made in vertical and horizontal models in the full range from 3 to 800 h.p.—pressures to 35,000 p.s.i., and *higher!*

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— before you okay the higher costs and breakage "headaches" of INSERTS or TAPPING

Type "F-Z" Screws are not available from stock, but may be made up, quantity permitting, with slotted or Phillips Recessed Head.

The P-K Self-tapping Screw fastening method has permitted big savings in many plastics assemblies – by eliminating inserts and tapping. Now, similar economies can be realized in a much broader range of plastic products, by the use of the P-K TYPE "F-Z" SCREW, designed especially for fastenings to comparatively thin sections and bosses in friable and brittle plastics.

This improved fastening has the combined features of two P-K Screws widely used in plastics assembly – the thread-cutting flutes of the Type "F" screw, and the coarse pitch, widely-spaced thread of the P-K Type "Z" Screw.

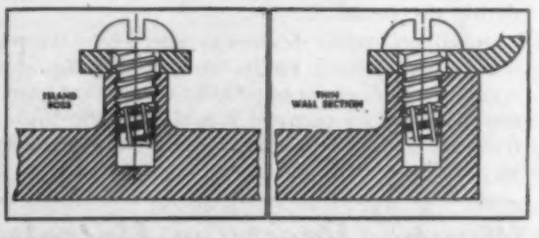
If high molding costs and excessive spoilage are shading profits on your product, it's plain common sense to find out NOW how you can make the assembly savings of 30 to 50 per cent often achieved with P-K Screws.

CHECK WITH A P-K ASSEMBLY ENGINEER. He'll help you find out if your assembly is one of the 7 out of 10 in which P-K Screws can be used to advantage. When necessary, he'll arrange a complete assembly survey of your product in P-K's fully equipped laboratory. He'll call at your request. If you prefer – send assembly details for recommendations. Parker-Kalon Corp., 200 Varick Street, New York 14.

FIVE CUTTING FLUTES distribute cutting pressure evenly – prevent localized pressure and cracking – especially in friable or brittle plastics, by permitting chips to drop to the bottom of the hole. The coarse threads eliminate binding by acting as an additional reservoir for the displaced material, and also offer greater resistance to stripping-out of the material.

PERMITS TROUBLE-PROOF DESIGN. The minimum stresses set up as P-K TYPE "F-Z" screws are driven permit design of plastic shells with more uniform wall sections. Excessive variation of thickness, as at bosses, often results in surface imperfections due to uneven curing. Fastenings with Type "F-Z" screws permit smaller bosses and thinner wall sections, with a resultant saving in material.

SEND FOR SAMPLES OF THE P-K TYPE "F-Z" SCREW . . . see for yourself its many advantages.



P-K Type "F-Z" Screws, used in structures like these, eliminate need for inserts or tapping for machine screws, speed up and simplify molding, reduce spoilage, and lower assembly costs.

Sold Only Through Accredited Distributors

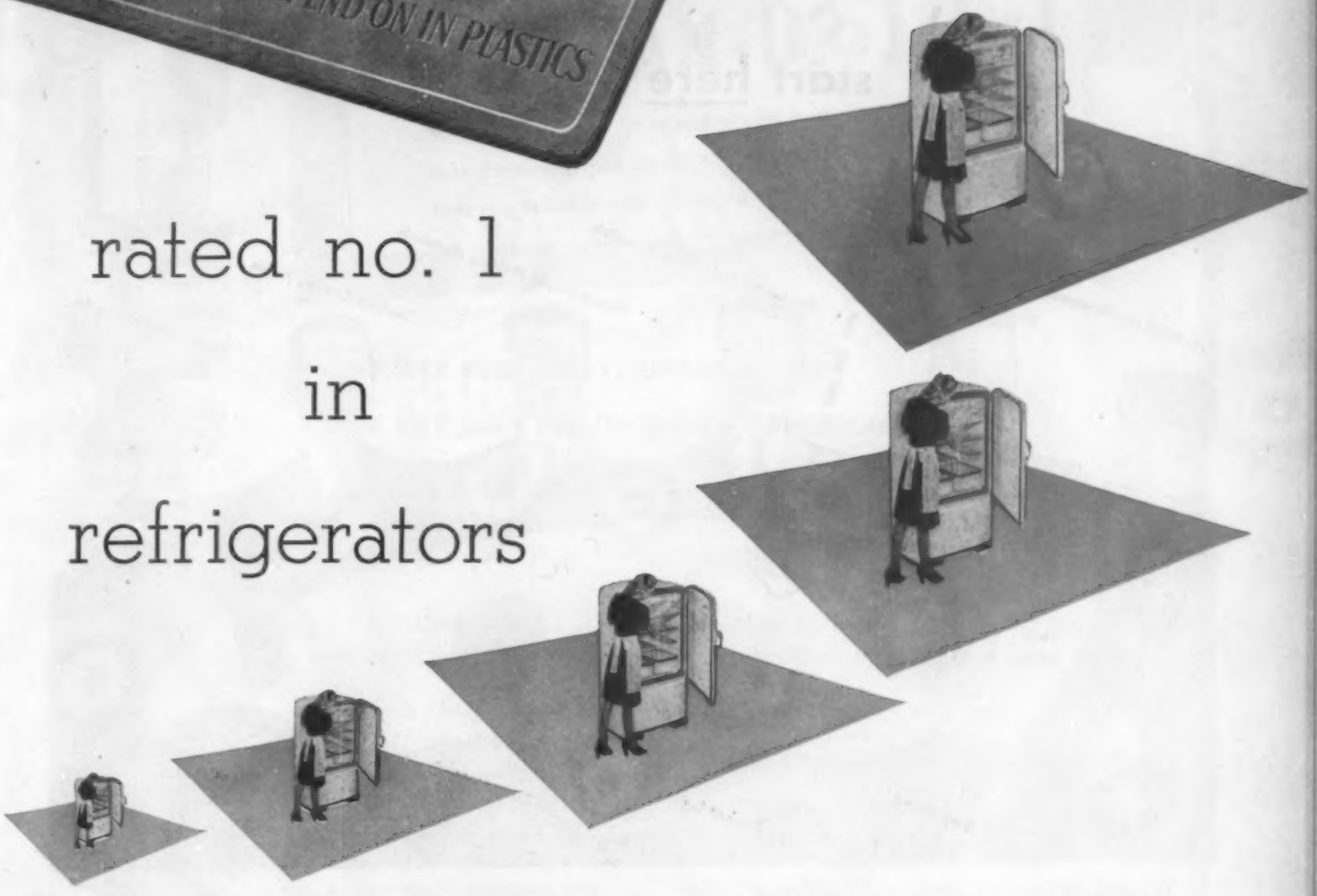
PARKER-KALON

P-K

SELF-TAPPING SCREWS

A FASTENING FOR EVERY METAL AND PLASTIC ASSEMBLY

rated no. 1 in refrigerators



Styron is a name that is growing in the refrigerator and other forward-looking industries—with reason!

Modern refrigerators gain a new measure of attractiveness —along with rugged serviceability—with parts made from this Dow plastic. Styron's easy moldability, low water absorption and dimensional stability at low temperatures are qualities that give it unique value for profitable production of fine refrigerators. That's why Styron is rated No. 1 in making ice compartment doors, crisper fronts and numerous other parts for today's leading refrigerators.

But its broadly useful properties and low price dictate the choice of Styron for a wide variety of products. Styron conveys clear brilliance to costume jewelry and cosmetic containers. Its acid resistance recommends it for batteries. Its high dielectric strength and low specific gravity suggest an ever-growing list of applications.

In refrigerators, in numerous products—Styron is the name you can *depend* on in plastics!

Let's work it out together

Success in plastics is measured only in end products. It calls for the combined efforts of manufacturers, designers, fabricators and raw material producers. Dow is ready to do its part. Call on Dow and get the most out of plastics.

PRESENT AND POTENTIAL USES: Lighting fixtures; insulators; battery cases; hydrometers; bumps; closures; food handling equipment; pharmaceutical, cosmetic and jewelry containers; costume jewelry; novelties; refrigerator parts; pens; pencils; liquid dispensers; escutcheons; chemical apparatus; dishes; lenses; decorative objects; trim.

PROPERTIES AND ADVANTAGES: Clear, translucent or opaque; broad color range; excellent high frequency electrical insulatory can "pipe" light through curved rod, and around corners; resistant to acids and many alkalies; low water absorption; light weight; rigid at low temperatures; limited solvent resistance; available only in rigid forms.

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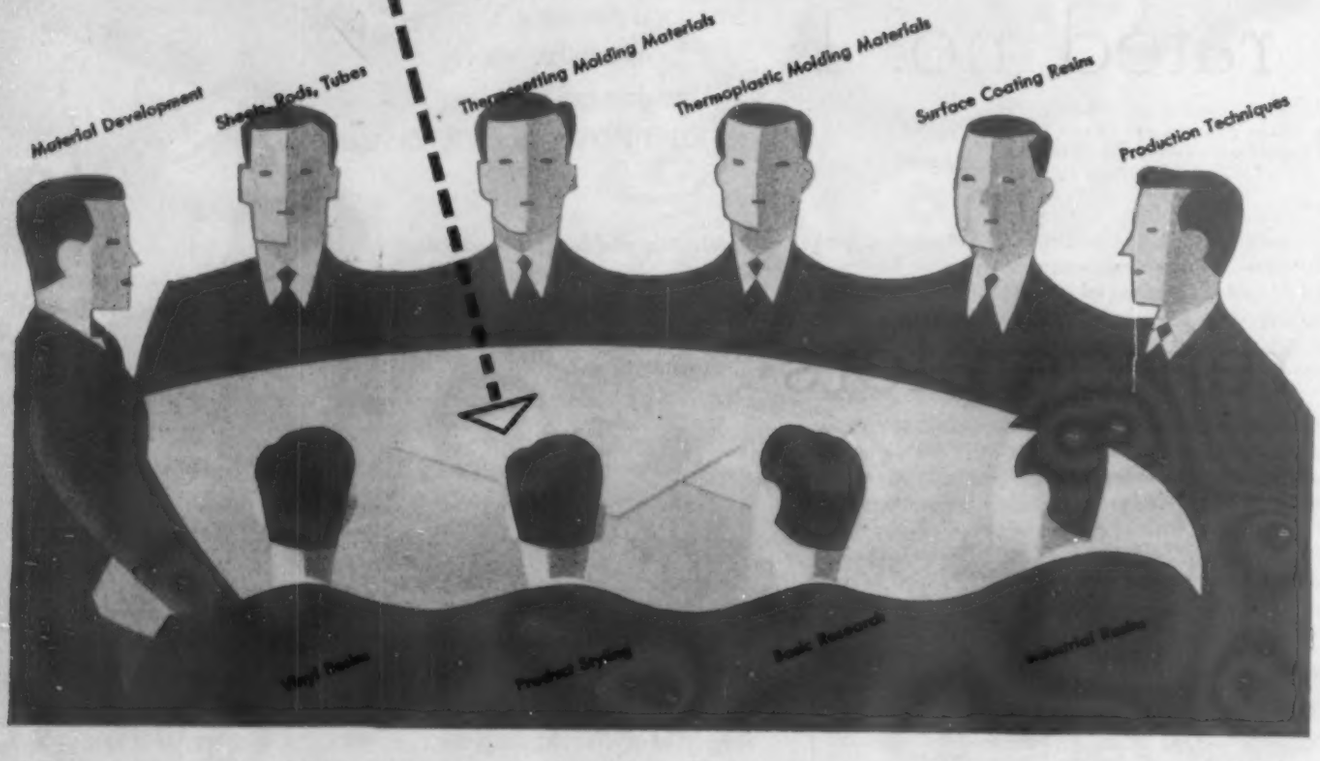
PLASTICS
ETHOCEL • ETHOCEL SHEETING
STYRON • SARAN • SARAN FILM

For a happy ending . . .

let your plastics planning

start here



You can avoid costly mistakes, second-rate results and loss of time by putting your plastics problems up to Monsanto's Plastics Technical Council *first.*

Already this group of ten picked plastics experts has given valuable help and advice to hundreds of molders, fabricators and end-users . . . authoritative, balanced counsel on materials, methods, designing, performance standards, etc.

Ten Heads Are Better Than One

This Council has been set up by Monsanto Plastics Division in answer to the needs of newcomers as well as veterans in the fast moving, ever growing plastics field. It is made up of ten experts, each one a highly qualified specialist in a different, major phase of plastics practice. Together they represent over 100 years of experience in this young industry.

How to Use the Council:

You only need to write a letter outlining your problem or your idea. The council will review your inquiry at its next regular weekly meeting. You will be sent promptly a written recommendation representing the thinking of the entire council . . . a comprehensive, practical report . . . something you can go to work with.

Unbiased Advice

With one of the broadest and most versatile groups of plastics in the industry, Monsanto's Council is under no compulsion or inclination to steer any inquiry toward one type of plastics. Also, no short-range interests are allowable; if it happens that Monsanto does not have a plastic that does the particular job in question, the inquirer is so informed.

If you have a plastics problem now . . . write to the Council for advice. To avoid delay you may wish to send in advance for our special questionnaire form. Address all inquiries: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile family of Monsanto Plastics includes: Lustron® polystyrenes • Cerex® heat resistant thermoplastics Vinyl acetals • Nitron® cellulose nitrates • Fibestos® cellulose acetates • Thalid® for impression molding • Resinox® phenolics • Resimene® melamines • Forms in which they are supplied include: Sheets • Rods • Tubes • Molding Compounds • Industrial Resins • Coating Compounds • Vuepak® rigid, transparent packaging materials.

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PLASTICS
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Abrasive-Belt SURFACERS

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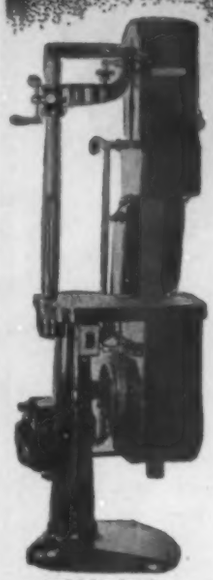
With so much of your net profit tied up in efficient, fast finishing, you can't afford not to know all about this remarkable new finishing method!



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MODEL G-4

- **WET BELT FOR THERMOPLASTICS**
- **DRY BELT FOR THERMOSETTING PLASTICS**

There's a Porter-Cable Abrasive Belt Surfacer that's exactly suited to your needs. Wet Belt, Dry Belt . . . or, if it fits your problem better, you can have BOTH in ONE MACHINE!

- **RUNS COOL . . . A fast-running belt that doesn't load means a cool cutting surface that effectively abolishes discoloration, and flow!**

- √ **5 to 25 Times Faster than many common methods**
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- √ **Requires minimum operator training**

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Measuring Mold Shrinkage

Peakes Rossi Flow Tests

High Frequency Preheating

TRAINING *in step with* INDUSTRIAL TRENDS

Plastics Institute training is predicated upon two basic principles:

A. Thorough study of accepted practices and materials.

B. Evaluation of current problems, new materials and new techniques.

THREE TYPICAL PHASES OF MOLDING TRAINING

Mold Shrinkage and After-Shrinkage Experienced plastics molders realize that there are still many problems to be solved in estimating shrinkage characteristics. Plastics Institute students explore such variables as pre-conditioning of molded parts, humidity, temperature, mold dimensions, etc.

Predetermination of Flow Plastics Institute students learn to evaluate the flow characteristics of molding compounds by orifice flow tests and Peakes Rossi flow analyzers, and how to translate this data into a production cycle. What effect humidity, pressure, high frequency preheating, storage, have on flow are typical student projects.

High Frequency Preheating High frequency preheating has resulted in a remarkable gain in plastics molding production speed and quality. Plastics Institute students study such variables as time of heating, power impact, rate of load application, and the time interval of applying load after removal from press.

In addition to molding, other phases of plastics thoroughly covered at Plastics Institute include: Materials, casting, mold design, fabricating and laminating. Industry type equipment is used in the classrooms.

Your inquiries regarding the Resident, Home Training and Study Forum Courses are welcomed.

VETERANS as well as CIVILIANS now training with Plastics Institute, upon graduation, are qualified and worthy of your consideration for employment in the various branches of the plastics industry. Write to the nearest branch of Plastics Institute stating your requirements. We will endeavor to select a graduate best qualified to meet your needs.

Write Dept. MP6-5

Plastics INDUSTRIES TECHNICAL INSTITUTE

Francis A. Gudger, President · John Delmonte, Technical Director

NEW YORK - 122 EAST 42ND ST. ★ CHICAGO - 221 NORTH LASALLE ST. ★ LOS ANGELES - 1601 SOUTH WESTERN AVE.

Plastic Parts for Electronics

● Amphenol has facilities second to none for quantity production of compression and injection molding, extrusion, and machining of plastics for communications and electronic applications. From raw materials to finished products Amphenol chemists, engineers, designers and production specialists insure the ultimate in performance characteristics — at low cost — to users of plastic components.

Plastic has long since ceased to be merely a substitute for other materials: its specific qualities and special properties make it indispensable in many modern applications. In many instances plastics have made possible entirely new approaches to development problems in the field of electronics.

Amphenol has long been a pioneer in development of new processes and uses for plastic fabrication. For precision processing of Polystyrene, Acrylics and Vinyls, consult Amphenol.

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Our woodflour and sawdust are made of the finest southern soft hardwoods. Softer woods impart lighter shades of color to the molded piece. We use the following woods, kiln-dried to 5%:

GUM — **COTTONWOOD**
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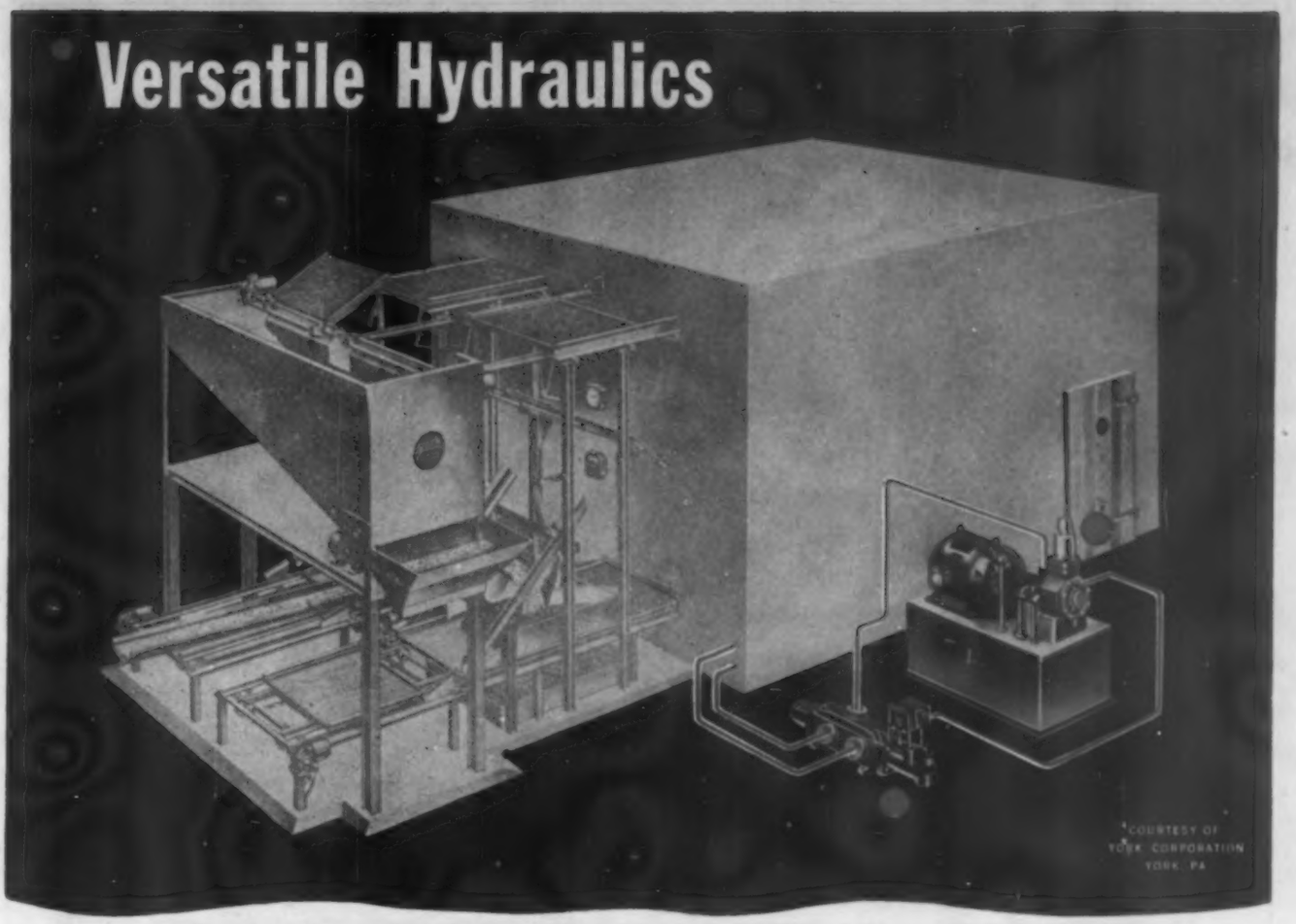
Our facilities produce up to 15,000 pounds of woodflour or sawdust per day, in any desired mesh. Inquiries and orders cordially invited.

CARLTON SMITH *Industries*

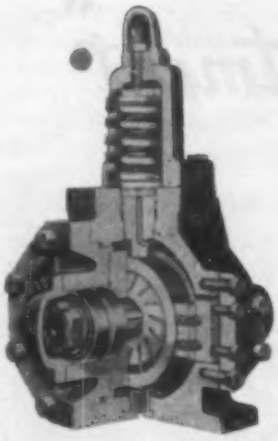
WOODFLOUR DIVISION

Beardon, Arkansas — **Memphis, Tennessee**

Versatile Hydraulics



WITH RACINE *Variable Volume* OIL HYDRAULIC PUMPS



IN THESE modern York quick freeze Units, Racine oil hydraulic Pumps and Valves operate and control the complete cycle of movement. Trays of food are, one by one, smoothly raised and moved in and out of the freezing chamber, then lowered by an elevator to the discharge position of the freezer.

Where you need smooth, positive and dependable action for holding, lifting, pressing, clamping, feeding, bending or embossing, use Racine *Variable Volume* oil hydraulic Pumps. Capacities 0 to 30 G.P.M. Pressures 50 to 1000 lbs. p.s.i. Our latest catalog P-10-C contains complete information on Racine Pumps, Valves and Pressure Boosters. Write for your Free Copy today. At the same time outline your hydraulic problems.

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Use Racine hydraulic Machines for all of your metal cutting. Capacities 6" x 6" to 20" x 20". Fully explained in catalog 12. Write.

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INJECTION MOLDING
MINCOR
"YOUR PLASTICS DEPARTMENT"

MINNESOTA PLASTICS CORP.

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FROM LABORATORY MIDGET TO PRODUCTION GIANT—

F/B CALENDER DESIGN FITS THE JOB

Here is an illustration of the wide range of sizes of Farrel-Birmingham Rubber and Plastics Calenders. From the 8"x16" laboratory size to the huge 32"x70" production machine, the physical proportions, materials, type of construction, lubricating systems, gearing, special operating features—in fact, every vital detail is designed to fit the job the calender is built to do. Here, in part, is how this principle is carried out in the units shown:

THE 32"x70" FOUR-ROLL PRODUCTION SIZE

Built for close control of gauge in double coating and multi-pass sheeting of rubber and plastics products, this calender has individual motors for each screw of the top, bottom and side rolls. This means that a screw can be operated independently to adjust one end of a roll, but can also be synchronized with the one at the other end for parallel adjustment.

Chilled iron rolls, carefully ground on the bodies and chamber-bored for steam circulation, are carried in full bronze-lined journal boxes. The housings and other parts are proportioned in size and weight to the large roils, which offer more than three times the resistance to deflection ordinarily provided. Lubricating systems which provide a constant supply of lubricant to all moving parts contribute to higher operating efficiency, reduced maintenance and longer life.

THE 8"x16" FOUR-ROLL LABORATORY SIZE

Designed for experimentation and for small production of rubber and plastics stocks, this unit is entirely self-contained, the drive being enclosed inside the base. Journal boxes are flood-lubricated, with circulating pump, oil cooler and oil sump tank mounted in the base. An adjustable speed motor provides the optimum operating speed for any individual stock.

Write for further information regarding calenders or any of the other equipment listed on this page.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

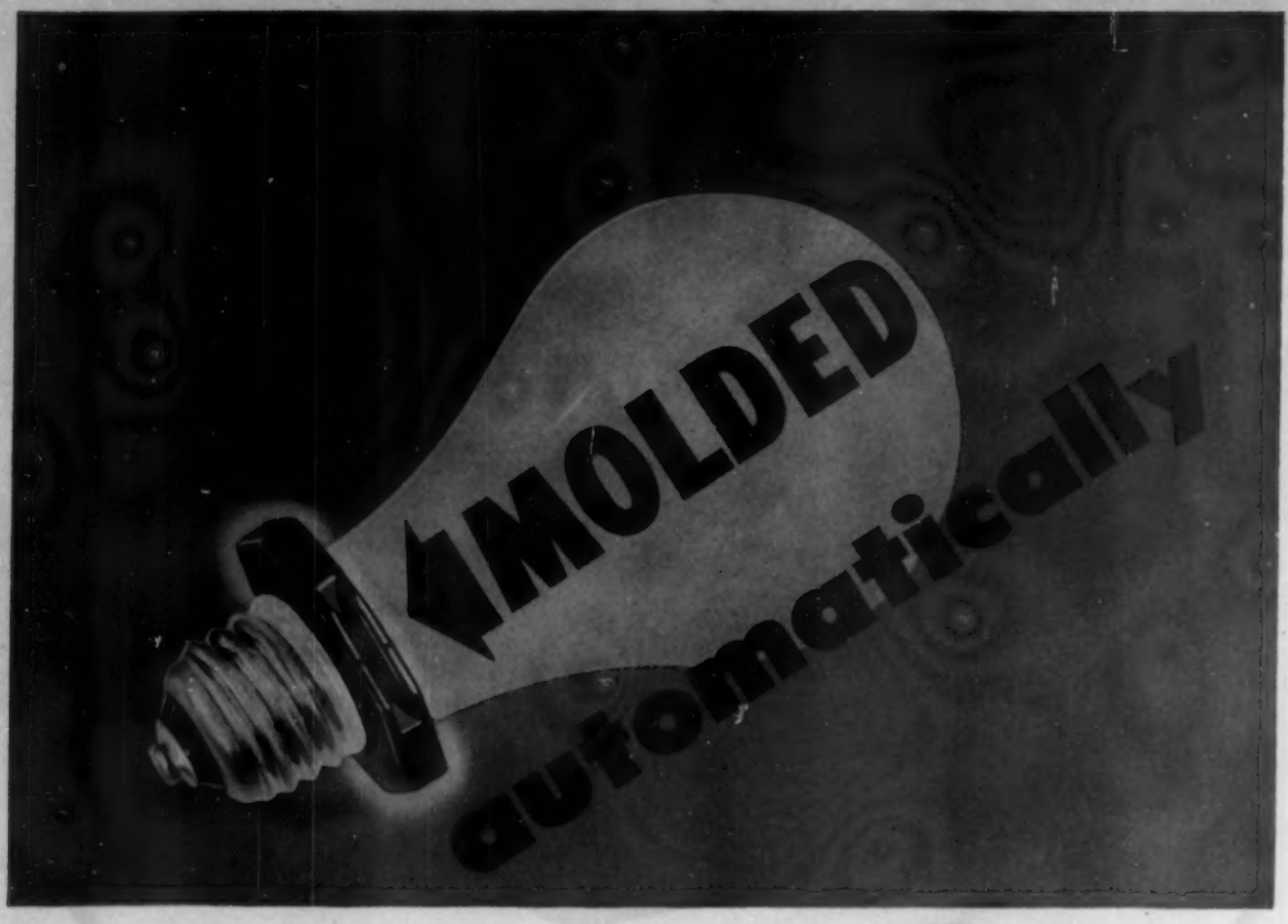
Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston, Charlotte.

F-B PRODUCTION UNITS

Banbury Mixers • Plasticators • Pelletizers • Mixing, Grinding, Warming and Sheeting Mills • Bale Cutters Tubing Machines • Refiners • Crackers • Washers Calenders • Hose Machines • Hydraulic Presses • and other equipment for processing rubber and plastic materials.

FB-2316

Farrel-Birmingham



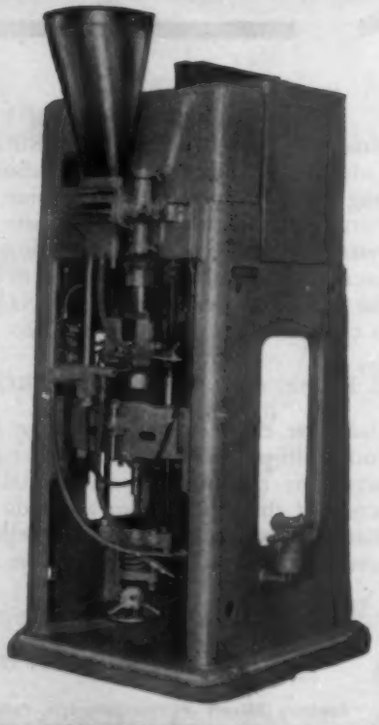
AT SUBSTANTIAL SAVINGS OVER CONVENTIONAL METHODS

When this three-way switch was put into production, both conventional molding methods and Completely Automatic Molding were investigated.

Analysis of all cost figures led to the selection of Completely Automatic Molding on many counts—lower mold cost, more quickly into production, minimum labor and finishing costs.

With Stokes Completely Automatic Presses, cycles are reduced through split-second timing. Flash losses are reduced 8% to 10% and more. Mold costs are low because few cavities do the work of many. Production design changes can be made quickly and economically. Molded parts are uniform, of highest quality, always accurate.

Investigate Completely Automatic Molding.



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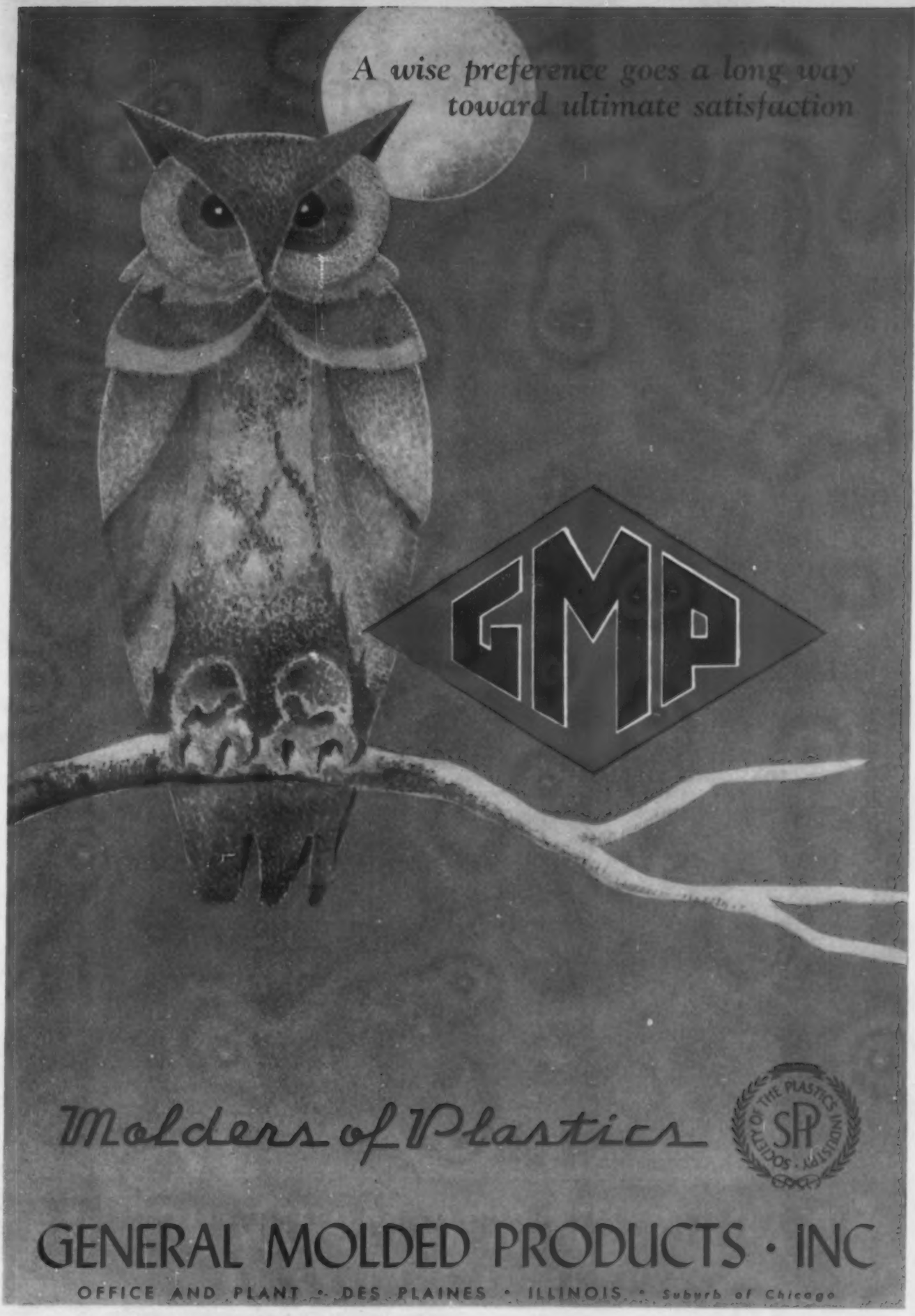
F.J.Stokes

AUTOMATIC
TABLETTING EQUIPMENT

FJS Est. 1895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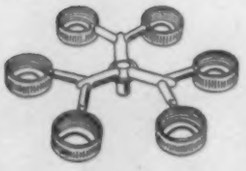
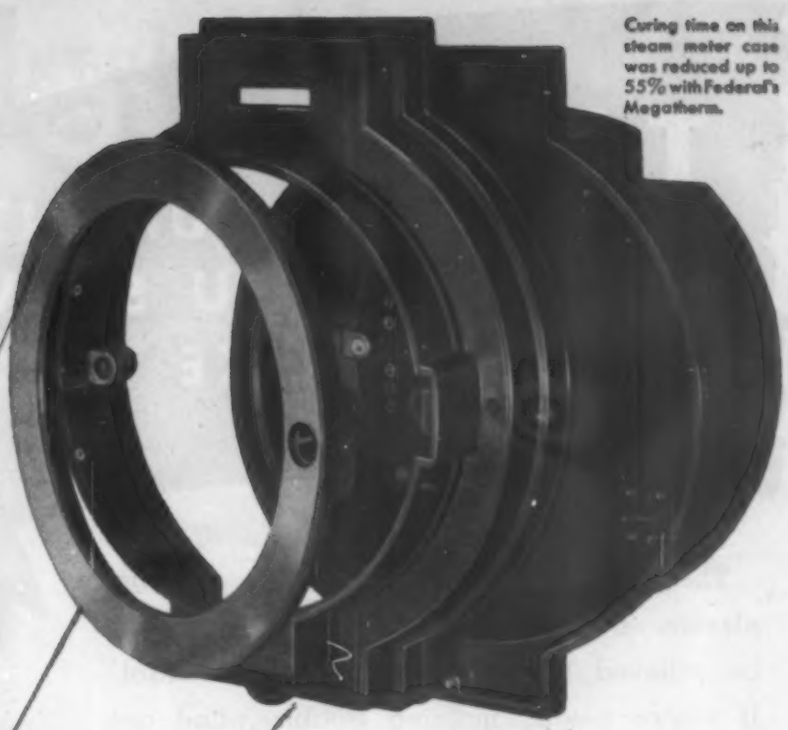


ST. LOUIS PLASTIC MOULDING CO.

SAINT LOUIS 8, MISSOURI



Curing time on this steam meter case was reduced up to 55% with Federal's Megatherm.

FOR
LARGE PARTS
OR SMALL

heating* preforms with MEGATHERM

Reg. U. S. Pat. Off.

is uniform . . . and fast!

Heating plastic materials prior to molding is a job for Federal's Megatherm. Because it does it dielectrically—therefore uniformly. And with its wide voltage range, accommodates a wide variety of preform sizes—*powdered plastics, too*—with the best voltage-per-inch for the substance. Coupled with high-frequency operation, this means *speed heating!*

Take the experience of the Watertown Manufacturing Company of Watertown, Connecticut, for example. Using Neillite, their own plastic material, curing time on the flat-iron handle shown here was *cut 25%*. For the large, compression-molded meter case, *curing time was reduced up to 55%*. What's more, with Megatherm heating, the case was molded in a *smaller* press than normally used!

Uniform heating with Megatherm means uniformly excellent plasticity in preforms . . . results in lower molding pressure requirements, in easier flow to all recesses of mold . . . saves dies . . . permits complex parts to be processed with precision. Write for details.

Curing time on this new type Manning-Bowman "swivel action" flat-iron handle was reduced 25% with Federal's Megatherm.

Federal Telephone and Radio Corporation

Export Distributor:
International Standard Electric Corporation

Newark 1, New Jersey

An IT&T Associate

TAG INSTRUMENTS CAN HELP YOU SOLVE PROBLEMS LIKE THESE

There are dozens of bugaboos in molding plastics—but a good percentage of them can be relieved by proper temperature control. If you're having molding troubles, find out how TAG instruments can help you solve them. Perhaps the experience of our engineers can suggest an instrument, or a better way to use one, that will assist you in turning out a better product, faster.

Write for CATALOG.

QUESTION: We mold large pieces of intricate shape. How can we get away from mold damage, which has been the cause of many shutdowns?

ANSWER: Correct, uniform heating of the molding compound is the only solution. It will eliminate the hard cores which are the cause of most mold damage.

QUESTION: Our engineer says we're losing time and production due to slow press closing. How can we speed up?

ANSWER: If the temperature of the compound is right as it goes into the press, and if correct plasticity is maintained, closing will be undelayed because flow will be fast.

QUESTION: Non-uniformity of color is costing us money on rejections. Can that be corrected?

ANSWER: Differences in color often are caused by differences in temperature. Get your mix correct at the beginning—then control the temperature!

TAG AUTOMATIC CONTROLLERS

Save time, labor and power—prevent spoilage and assure product uniformity. Available in three types: High Sensitivity (On-Off); Full Range Throttling; and Full Range Throttling with Automatic Reset—all indicating and recording models—a specific model to fit every operation.

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MANUFACTURERS OF: LAWN MOWERS • ELECTRICAL APPLIANCES • PRECISION STAMPINGS
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Why clinch, stake or weld ?

Just snap in a latching SPEED NUT

A PRESS OF THE THUMB SNAPS LATCHING TYPE SPEED NUT SECURELY IN PLACE
SPEED NUTS eliminate handling of material
DON GOOTON

A SPEED NUT CASE HISTORY

A motor truck manufacturer used a battery of machines to clinch nuts in place for assembly of dash to cowl and attachment of instruments and equipment to dash. Two men were required to operate each machine . . . to handle the large stampings and position them for attachment of the fasteners. This extra handling meant frequent damage to stampings, and then after painting, nut threads had to be re-tapped.

30 self-retaining Speed Nuts are now snapped in place by hand on each stamping as it moves from the press department on conveyers. The entire assembly is completed in much less time, machines eliminated and costs substantially reduced.

Sure, there are a lot of ways to attach nuts to mid-sections of panels for blind location assembly, *but* they require expensive equipment, valuable floor space and skilled operators. Panels must be taken off conveyer, carried to press or welder and carefully positioned to attach the fasteners.

Now with Latching type Speed Nuts, panels stay right on the conveyer, and the assembler merely snaps the Speed Nuts in place by hand. These Speed Nuts are *self-retaining*, holding themselves firmly in place until the screw is driven from opposite side. Moreover, Speed Nuts provide a spring tension lock that holds tight under the most severe vibration.

We've developed many types of self-retaining Speed Nuts to simplify and reduce the cost of blind location fastening. We'll be glad to show you how they can improve the assembly of your product. Send in your details today!

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In England: Simmonds Aerocessories, Ltd., London
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Speed Nuts*

MORE THAN 3000 SHAPES AND SIZES

PATENTED

* Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS

IF YOU NEED HEAT TREATING EQUIPMENT NOW!

...and cost is a major factor— take these **3** *steps . . .*

1° DETERMINE ACCURATELY YOUR OWN NEEDS

We can make it worth *your* while to determine for yourself the kind of equipment you need, its capacity, rating, etc. If you can give us accurately the limit conditions of your needs, we can almost certainly locate surplus low cost equipment to fit those conditions.

2° ESTIMATE THE COST YOU CAN AFFORD

Our principal objective is to get this equipment into *your* hands and actively producing urgently needed goods. In pricing, every consideration will be given to the necessary adaptations of the furnaces to your particular needs.

3° FILL IN AND MAIL THIS COUPON

ROTARY HEARTH
For heat treating in production operations. Semi-automatic operation and control.

TEMPERING FURNACE
For tempering small work in production or for the tool room or laboratory.

INDUCTION HARDENER
The latest development in controlled surface hardening by high frequency induction.

VETERANS OF WORLD WAR II

To help you in purchasing surplus property, veterans' units have been established in each War Assets Administration Regional Office.

To War Assets Administration: Please send me information on the following types of surplus Heat Treating Equipment.

FUEL	INTENDED USE	TYPE OR MAKE
☐ Electrical	.....	.....
☐ Gas	.....	.....
☐ Oil	.....	.....
☐ High Frequency Induction	.....	.....

I am also interested in ☐ heating furnaces, ☐ melting furnaces, ☐ dryers, ☐ kilns.

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City ..... State 174-1

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Latest Monarch Lathe Development Uses

Designed to do work that heretofore has necessitated considerable special engineering — and to do it quickly, accurately and easily — the Monarch Moldmaker's Toolroom Lathe is the latest addition to the Monarch line.

Briefly, this machine solves the problem of shrinkage in making molds for producing accurate threaded parts for the plastics, molded rubber goods, powdered metal and porcelain industries, where the threads in the mold must have a longer lead than those in the finished parts.

It eliminates the necessity of making special change gears for each different type of mold. A lead screw varying mechanism — an inherent part of the lathe — makes it possible for the regular quick change gear box to be used for all lead screw variations. Thus the machine can quickly be set from one job to another.

Twenty Timken Tapered Roller Bearings applied throughout the lathe — including the mounting of the main spindle — help to assure the necessary precision, speed and endurance. You can have the bearing performance so long enjoyed by The Monarch Machine Tool Company by making sure that the trade-mark "TIMKEN" appears on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

WORLD'S LARGEST PRODUCER OF SYNTHETIC RESINS

RCI

for fast-curing • low-pressure molding

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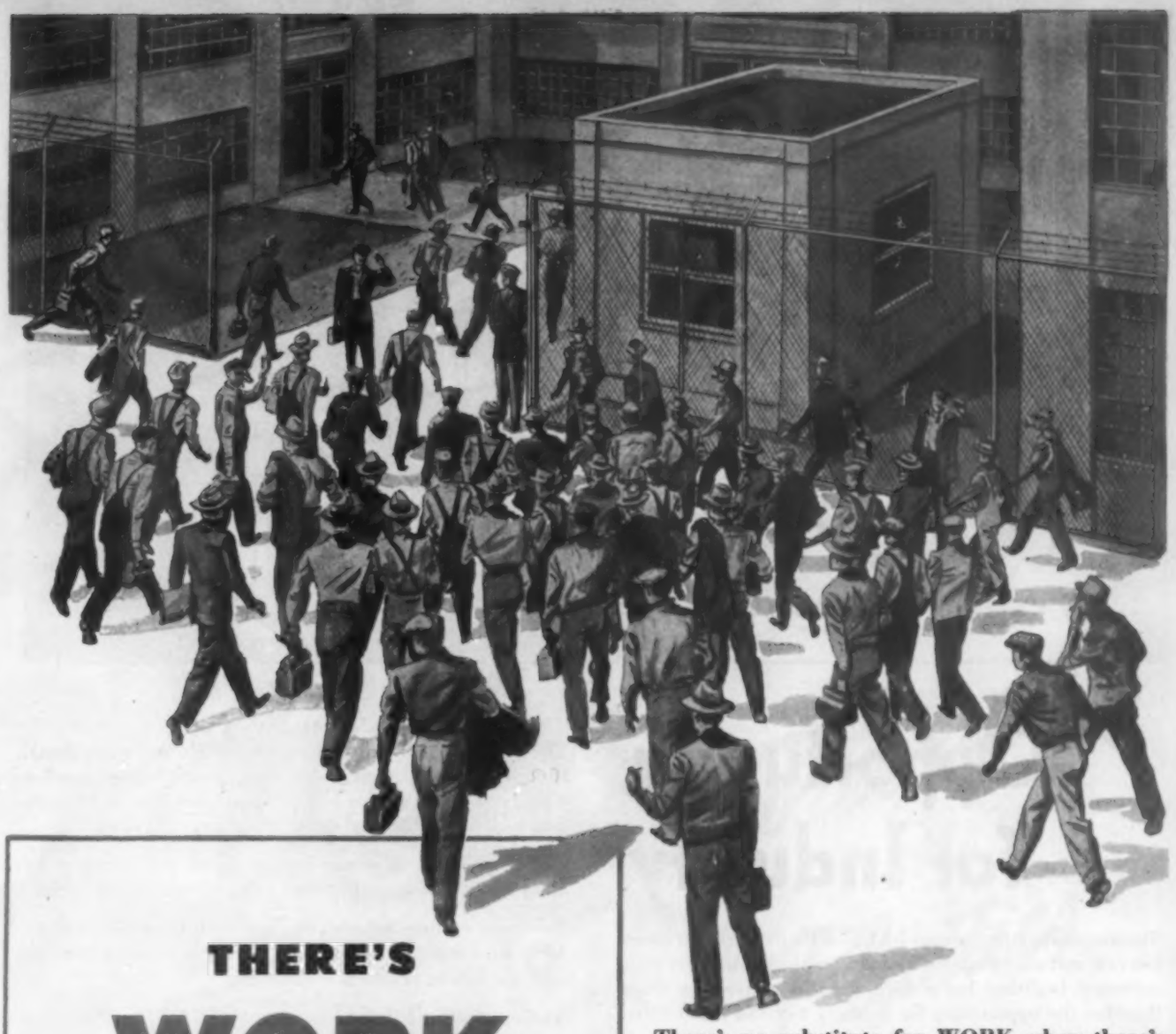

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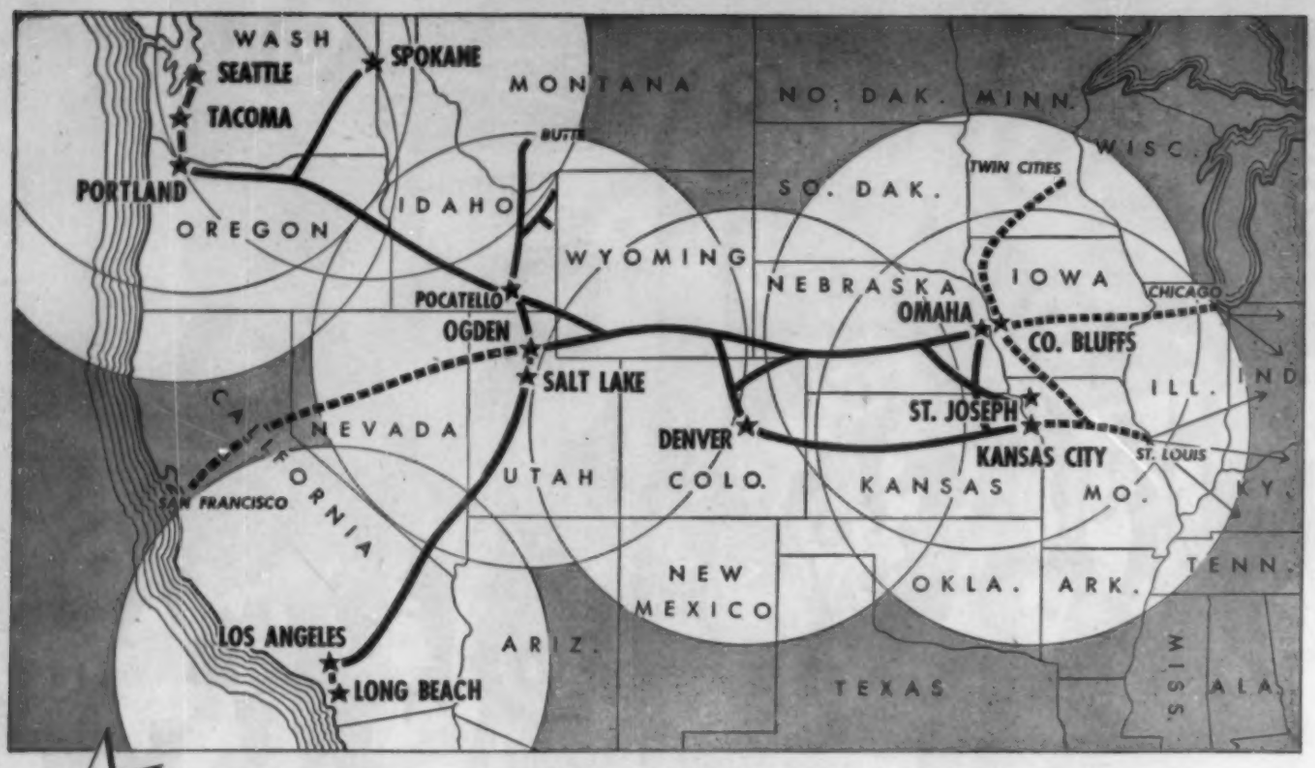

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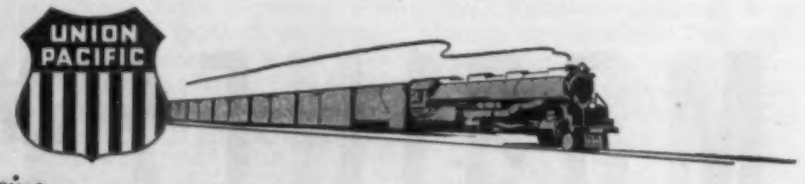

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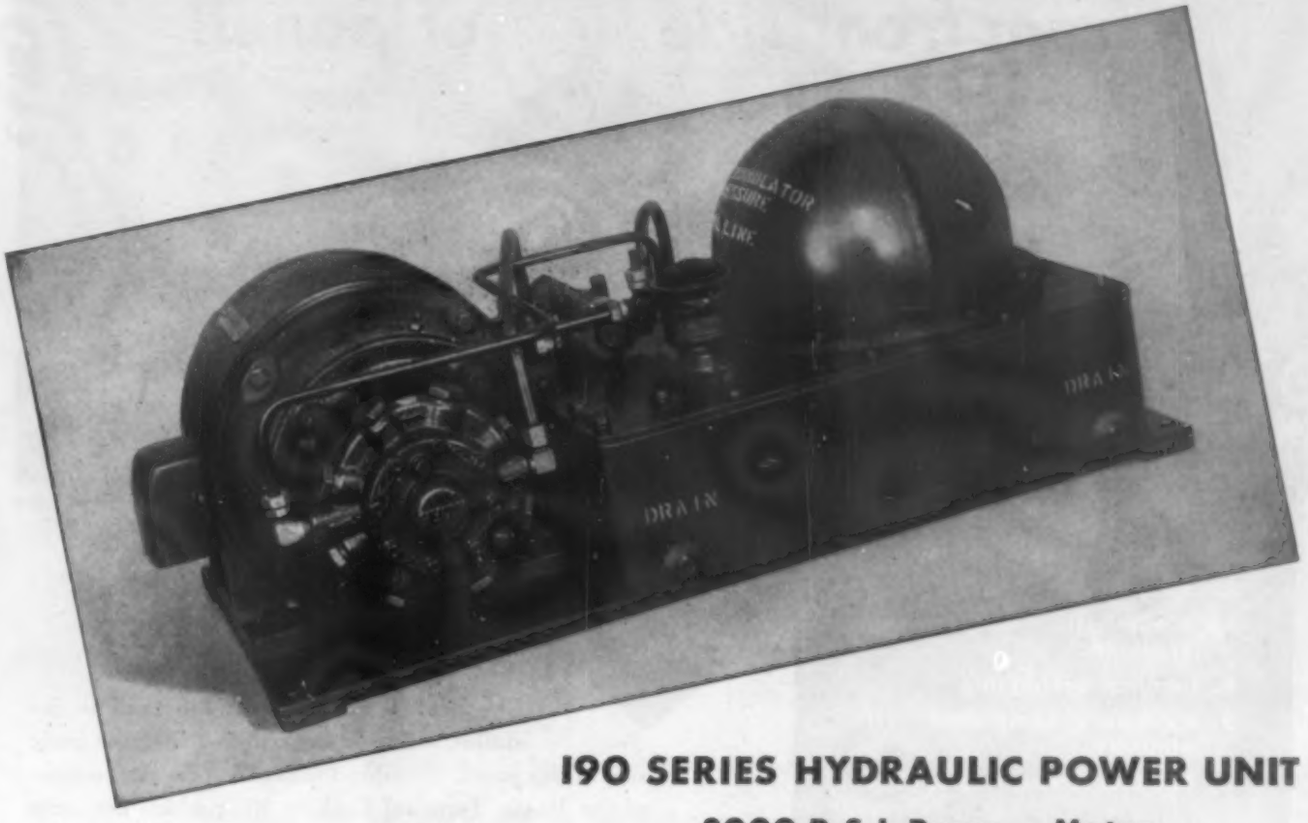

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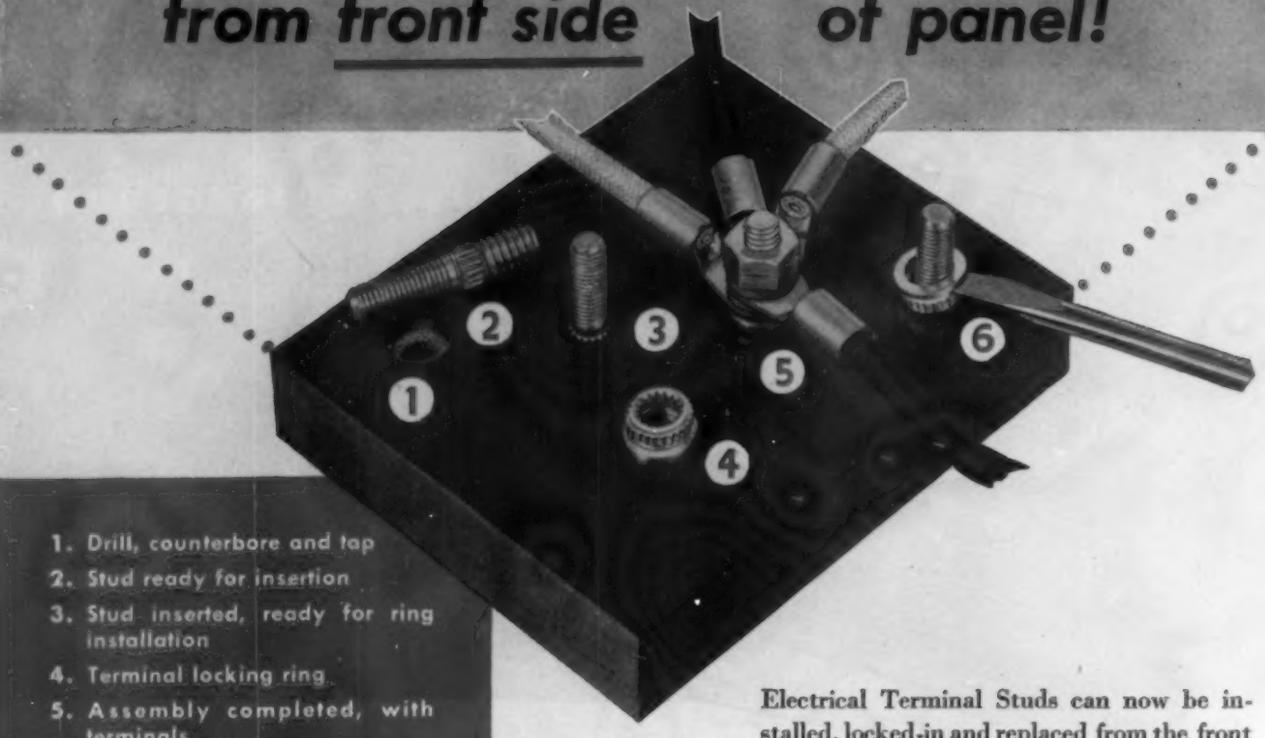
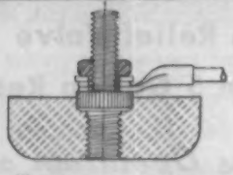
Rosán ELECTRICAL TERMINAL STUDS

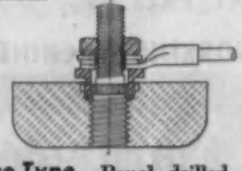
Installed . . . Locked in . . . Replaced from front side of panel!



1. Drill, counterbore and tap
2. Stud ready for insertion
3. Stud inserted, ready for ring installation
4. Terminal locking ring
5. Assembly completed, with terminals
6. Terminal locking ring removed



Molded-In Type. Terminal Stud molded solidly in panel, can be removed by simple means and replaced with two-piece type without damage to material or disturbance of other terminals.



Two-Piece Type. Panel drilled, counterbored and tapped, terminal stud inserted and locked with ring. Quick and easy removal may be effected as indicated. (No. 6 above)

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MODERN PLASTICS
VOLUME 23 MAY 1946 NUMBER 9

PHOTO, COURTESY INTERNATIONAL NEWS SERVICE

More plastics in *Juke boxes*

Color and light weight are the chief reasons for the increased use of plastics in juke boxes, and in the vending and coin machines discussed in the two articles that follow

THE new automatic phonographs, the *juke boxes* of the coke and bobby-sox crowd, are finally coming off the production lines. Thanks largely to plastics, they are really something to see.

"When I first saw that new model," exclaimed one salesman, "my first impulse was to put mayonnaise on it and eat it!" A bit overdrawn perhaps, but there appears to be no doubt that America's musical appetite, be it for swing, sweet or classical selections, will continue to find the decorative plastic components of automatic phonographs a pleasing complement to the main course.

Business Week estimated recently that some 400,000 automatic phonographs of 1942 vintage, which took quite a beating during the war years, are due for replacement when the industry gets into full production. While an estimate of the volume of plastic components involved in this huge postwar market is difficult to make, because of the varied applications used by different manufacturers and the frequent design changes, most of the major producers are now far enough along on their new models to permit an appraisal of some of the principal trends shaping up in this lively industry.

The beauty of plastic materials has always made them a natural for automatic phonographs. Light in weight and easy to handle, plastics enable the cabinet designer to let himself go, as it were, on distinctive styling and arresting lighting effects. And examination of the first postwar models proves that these men are taking full advantage of warproved materials and techniques to enhance the appearance and performance of their machines.

Formed acetate and acrylic sheeting

One of the first manufacturers to get into production on its postwar line of automatic phonographs, the J. P. Seeburg Corp., has several interesting new applications of plastics. The company is utilizing formed cellulose

ENJOYMENT WITH PLASTICS

PHOTO, COURTESY J. P. SEEBURG CORP

1—*Features of this new postwar automatic phonograph unit are pilaster sections formed from cellulose acetate sheeting and a decorative translucent dome of acrylic*

acetate sheeting for the pilasters on its new models and a special type of colored translucent Plexiglas sheet for the dome section. Pilasters are in red and the dome in either translucent red or in a mottled effect. The machines are equipped with interior lights which glow warmly through the plastic panels.

The incorporation of formed cellulose acetate and acrylic sheeting in the new Seeburg automatic phonographs represents a substantial departure from the company's prewar use of plastics. Some experimental work had been done with formed acetate sheets, but the company's general practice prior to the war called for the use of cast resins as decorative panels. Receiving the rough castings, the firm handled the finishing operations, including sanding, buffing and polishing, in its own plant. As increasingly complex shapes were designed, difficulties in casting were experienced. And some of the castings required a great deal of fabricating work before they were ready for installation.

As a result of these production problems, the company has now gone over entirely to the formed sheet materials. The lighter weight of these sheets permits the use of larger plastic areas without a weight penalty —an important consideration when shipping the machines or in placing them on location. Some prewar models carried as much as 20 to 25 lb. of cast resins.

Further uses of plastics in the new Seeburg models include injection-molded sections of red cellulose acetate in the dome ventilator unit on top of the machines and injection-molded selector bars of clear Plexiglas. Numbers on the bars are engraved with dies and red enamel wiped in to increase legibility.

The front dome ventilator section carries the company name in script, molded in, wiped with gold enamel for contrast with the red plastic. At present, rayon cloth is used as a decorative covering over the speaker grille, but a change may be made later to a material woven of plastic monofilaments, to give added sparkle to this part of the cabinet.

Material selection

In utilizing plastics in automatic record playing machines, many factors besides appearance must be closely watched. Mr. Miller, Seeburg's designer, states, for example, that if too much plastic and not enough wood are used in a cabinet, objectionable vibration and noise may result. The sound deadening properties of wood are vital to the attainment of proper tone quality.

From the standpoint of design, particular care must be taken to insure that the curves used in the plastic panels will not produce serious internal strains in the material. Sharp bends which call for excessive stretching of the sheets in the forming operation result in thin spots and must be avoided.

Fastening the plastic sections in the cabinet requires a method which will assure a close, attractive fit, yet make due allowance for the fact that the machine may be carried on a truck through sub-zero temperatures and abruptly transferred to a heated room. The plastic sections may be fastened to the wooden frame members by means of wood or metal strips, or by drilling the material and screwing it directly to the cabinet, using washers of rubber, fiber or other resilient materials for insulation.

On account of their frequent location in taverns and other places where liquor is served, automatic phonographs must be able to withstand occasional accidental spilling of alcoholic drinks. In this respect, many plastics work out quite satisfactorily, not being harmed by the dilute alcoholic solutions encountered. Cigarette burns, another operational hazard, can be sanded out and a smooth finish restored, provided the burns are not too severe.

An emphasis on cast resin

Brilliant color and animation, achieved through the use of plastics and interior illumination, mark the new Model 1422 automatic phonograph now coming off the assembly lines of Rock-ola Manufacturing Company. This postwar model, typifying the trend toward more compact easier-to-service units, incorporates cast resins, cellulose acetate sheet material, molded acetate selector buttons and extruded acetate decorative trim. The cabinet, done in richly grained walnut veneers, has a large ornamental die casting which frames the front panel, backed by vari-colored cellulose acetate sheeting at the top and silk material in the lower portion, behind which the speaker is mounted.

Seven cast resin sections of Catalin form the pilasters, corner caps and top center decorative panels of the new Rock-ola model. Two vertical sections on each side, featuring a ribbed design, and the upper section, on which the company name is mounted in metal, are of Catalin Opalite, in a diffused pink shade, while the two corner caps are of translucent white mottled with a bright cherry colored material.

The pilaster sections are lighted from within by standard fluorescent tubes enclosed within cellulose acetate color cylinders. Screened with a rich variety of pleasing hues, the cylinders impart a rainbow effect as they revolve slowly behind the fluted vertical sections. The large sheet of acetate material behind the die-cast front is also screened in variegated colors and is illuminated by two smaller revolving cylinders of

2—Its hard to imagine juke boxes stripped of bright colors. In part that explains the growing popularity of plastics in these units, although resistance to staining and light weight are important

COLOR PLATE, COURTESY RUDOLPH WURLITZER CO.

3 PHOTO, COURTESY AIREON MFG. CORP.

4 PHOTO, COURTESY ROCK-OLA MFG. CO.

3—A departure from the usual juke box design is this model in which red "wing tips" and yellow pilaster sections are formed acrylic sheet. Interior illumination is diffused through clear acrylic panels. 4—Here fluorescent tubes, encased in cellulose acetate cylinders, light the pilasters

color-screened acetate sheeting. These cylinders employ several incandescent bulbs rather than fluorecent tube lighting.

Curving an extended H-section

An interesting application of extruded decorative trim is involved at the joint between the two vertical pilaster pieces on either side of the cabinet front. The company takes lengths of ribbed H-section acetate trim and saws them into short pieces to be used as a connecting link between the pilaster panels. Finished edges of the cast pieces fit into the groove formed by the open ends of the H.

In order to match the contour of the cast sections, these trim strips must be curved—something which an H-section refuses to do without preliminary treatment. In this case, the problem is surmounted quickly and economically by placing the cut sections in a fixture and sawing a series of 20 slots in the back of the section, using a multiple-bladed saw arrangement. The slots formed by this operation are $^1/_{16}$ in. wide and are spaced $^7/_{32}$ in. apart. After this treatment, the channels are quite flexible and may be mounted in the curved cabinet without any special forming operation. When the prepared strip is bent, the slots in the back take up the compressive strain by closing up. The new Rock-ola model also uses selector buttons injection molded of cellulose acetate in a brilliant and rich ruby color.

According to A. R. Kelso, executive vice-president of Rock-ola, the company has made extensive use of plastic components in its automatic phonographs since 1939 and has found them ideal for applications requiring a combination of strength and decorative value. Cast panels in the new Model 1422, it is pointed out, provide richness of illumination because there is no filler content in the material to obstruct the passage of light, and also possess adequate strength to meet normal operating conditions.

Plastics also used for functional parts

In its new Model 1015 automatic phonograph, the Rudolph Wurlitzer Co. makes liberal use of several plastic materials for functional as well as decorative applications. This striking postwar design gains much of its eye-appeal from colorful, gracefully curved pilaster sections of formed cellulose acetate sheet material, illuminated from within by incandescent bulbs and fluorescent tube lights enclosed in color cylinders. The company states that the dimensional and color stability of acetate under a wide range of conditions were important factors in specifying it for the pilasters and several other components.

Light shields within the cabinet, utilized to confine and direct the lighting for maximum illumination

are of Insurok, selected for this application for its toughness and heat resistance. The larger shield is curved to cover five bulbs which light up the curved top sections of the phonograph, while the other shield, circular in shape, encloses a single bulb which illuminates a decorative acetate insert centered low in the die-cast front grille. Injection-molded selector buttons, of Tenite, and acetate switch covers represent additional plastic applications in this model. The over-ride switch plate, another concealed functional part, is of polystyrene.

Plastics also figure prominently in the new Wurlitzer wall boxes, which are designed to provide remote control of the automatic phonograph, enabling patrons to make their record selections and operate the machine without leaving their tables. The coin indicator plates on the new boxes are of Lucite, wall box selector buttons are of Tenite, while the arrow indicator and large selector dial on the Model 3031 30-wire wall box unit are molded of polystyrene. Polystyrene also forms the decorative red jewel mounted in the base of this wall box model.

Three other lines of juke boxes

Aireon Manufacturing Corporation is entering the postwar automatic phonograph field with its Airliner electronic model designed by Raymond Loewy Associates, which involves a number of plastic components. These include red *wing tips* and yellow pilaster sections of formed Plexiglas sheet, as well as selector buttons, coin rejectors, escutcheons, windows, diffusing screens and color disks. Interior illumination is diffused through clear acrylic panels in the front of the cabinet.

Injection molded parts comprise four red opaque push buttons, one transparent selector key and cover of polystyrene and four clear acrylic escutcheons. Two interior color disk pieces, screened on Vinylite sheeting, provide colorful lighting effects.

Postwar automatic phonographs soon to be introduced by the John Gabel Manufacturing Co. and Bally Manufacturing Co. will incorporate both formed and cast plastics, it is reported. Although detailed information on these machines is not yet available, the manufacturers state that they are planning to make use of formed Plexiglas sheet material and also to use cast plastics for special decorative applications.

Plastics for remote control units

The Buckley Music System, makers of the Music Box remote-control unit for automatic phonograph installations, used plastic inserts on each side of the die-cast, chrome-plated case in its prewar models and plans to continue this application, possibly modifying the method of fastening the inserts in place to protect them against being pried out by meddlesome patrons. The case is illuminated from within, diffusing the light through the decorative plastic panels and greatly enhancing the appearance of the unit. The control handle on the cabinet, used in selecting records, is of phenolic material.

Introduced just prior to the war, the Panoram self-contained sound motion picture unit manufactured by Mills Industries, Inc., added a new dimension to coin-in-the-slot entertainment. In this machine, the deposit of a coin brings a three-minute movie with sound—an orchestra, dance routine or other form of entertainment sharply projected from within the cabinet on a plastic screen measuring approximately 18 by 24 in. by $^1/_{16}$ in. thick. This flexible screen, sturdy and light in weight, has a cellulose acetate base and is non-combustible.

Present plans of the Mills organization call for modification of the Panoram cabinet and the use of a similar screen measuring approximately 23 by 30 in., adequate for an audience of 200 or more persons. The same type of screen will also be incorporated in the company's new Sono-Vision unit, a non-coin-operated device which will be used for advertising, sales promotional and educational purposes.

So continues the march of plastics in the automatic phonograph and coin-in-the-slot entertainment field. As engineers and designers, ever alert to the challenge of new materials and fabrication methods, gain further knowledge of what plastics have to offer this enterprising industry, even more advanced decorative and utilitarian applications may be expected.

Credits

Seeburg cabinets: H-section, Superior Plastic Co. Rock-ola cabinet: selector buttons, Chicago Die Mold Mfg. Co. Aireon cabinet: wing tips and pilaster components, William H. Van Gaasbeck Co. and Eclipse Moulded Products Co.; push buttons, selector key and cover, escutcheons and color disk pieces, G. Felsanthal & Sons. Buckley control box: forming work, Paramount Plastics Co.; control handles, Harry Davies Molding Co.

5—Formed panels of cellulose acetate sheet are used in the sides of this remote control unit for juke boxes

PHOTO, COURTESY BUCKLEY MUSIC SYSTEM

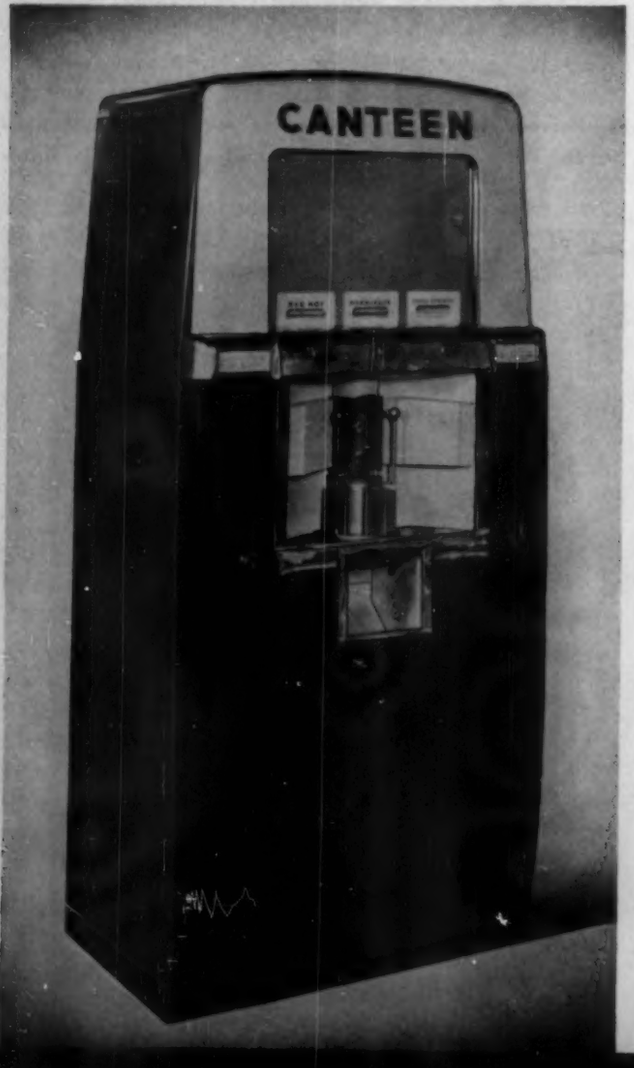
Utility the thing in *Vending machines*

HUNGRY for a hot sandwich? Thirsty for a drink of your favorite carbonated beverage or fruit juice? Just deposit a coin in the slot of one of the efficient new postwar vending machines, and you'll get service in a hurry. And you'll immediately be impressed by the important role which plastic components are playing in both the appearance and operation of purveyors of an ever-widening variety of food products, confections, gum, cigarettes and other items.

What will be the part played by automatic vending machines in the future? Many men in the industry point out that the devices fill a distinct need in the nation's merchandising structure. They increase total sales of quick turnover items and reduce overhead costs. They do not compete with personal selling, but supplement it, operating in locations where the use of a salesperson would be expensive or impracticable.

1—Injection molded polystyrene panels line the interior of the display compartment of this dispenser where sandwiches are heated electronically before delivery

PHOTOS 1 & 2, COURTESY AUTOMATIC CANTEEN CO. OF AMER., PHOTO 3, COURTESY THE VENDO CO.



1

The full scope of the coin machine industry is seldom realized by the layman. At the end of 1941—the last normal business year—there were approximately 126,500 cigarette vending machines and 28,000 beverage vending machines in operation, according to an industry census published in March 1945, by *Billboard Magazine*. Added to these were 250,000 candy bar vending machines, 3,000,000 penny vending devices and some 25,000 miscellaneous vending machines.

During the war, thousands of worn out or obsolete machines were retired from service and not replaced, creating a postwar demand of staggering proportions for all types of coin-operated devices.

The steadily increasing use of plastics in coin machines is a trend which the industry has watched with a great deal of interest. With leading manufacturers now readying their new models, investigation discloses that plastics, while continuing to find many decorative applications, are also being called upon for new and interesting functional tasks.

Progress made by plastic materials in the coin machine field has always been closely bound up with the conditions which these units encounter in service. The life of a vending machine is no bed of roses. If a machine is empty or when, on rare occasions, the mechanism jams, it may be subjected to some extremely rough treatment—banging, shaking and probing.

A hot dog dispenser

Among the most interesting of these new applications is a hot sandwich dispensing unit soon to be placed in operation by Automatic Canteen Co. of America. This machine has an electronic cooking mechanism which will heat prewrapped sandwiches before the purchaser's eyes, affording hot, nourishing food literally at the drop of a coin.

Injection molded panels of polystyrene will be used in the interior of the display compartment enclosing the sandwich. These white, maroon and gold sections will not only draw attention to this important part of the machine, but will also have a functional use; polystyrene was selected for this application because of its exceptionally low power loss factor.

This new unit will also have several more conventional types of plastic applications. Letters forming the name *Canteen* across the top will be of polystyrene, as well as a combination push button and indicator which will light up from within and show the word *empty* when the machine is out of the type of sandwich selected by the patron.

During the war period, Automatic Canteen Co. used

2

3

2—A vending machine for dispensing nuts, candy bars and gum uses a cellulose acetate portion wheel in the left compartment and an acrylic window in the center. 3—Phenolics are employed throughout this beverage dispenser. The gasket retainers are formed from paper-based phenolics, the door guides and gasket bearing are laminated of the same material and the service door and the sill are molded

molded cellulose acetate portion wheels on its selective nut Canteen to replace the standard aluminum wheels. This wheel, measuring approximately 4 in. in diameter and slightly over an inch in thickness, contains four portion pockets in the outside edge and rotates a quarter-turn each time the machine is operated, delivering the proper portion of nuts. The company reports that the plastic wheels gave satisfactory service, although occasional warpage was experienced and it was necessary to avoid excessively hot water in cleaning them.

Another recent application of plastic materials in this company's vending machines involves the use of Plexiglas display bar compartment windows on the selective Candy Canteen unit to reduce breakage and pilferage. The plastic material has given good results in these machines, although some tendency to turn brittle in cold locations has been reported.

Beverage dispenser

The Vendo Co., long-time supplier of vending machines for bottled Coca-Cola, is using several plastic components in a unit which will dispense 83 bottles of the beverage and pre-cool 75. The company reports that incorporation of plastics in this machine, rather than other materials which would have been mechanically satisfactory, is due chiefly to the low conductivity factor of the materials.

Black Bakelite with paper base is used for gasket retainers, while the low thermal conductivity and good bearing qualities of laminated phenolic brought about its selection for door guides. Molded phenolic material is used for service door molding and sill, and Insurok is employed as a gasket bearing due to its self-lubricating properties.

A new Coca-Cola vending unit being brought out by Mills Industries will utilize Plexiglas to achieve a dramatic show-window effect for a bottle of the beverage on display. Use of the plastic material in this instance, according to Mills engineers, is based upon its excellent optical properties and resistance to breakage. The same plastic will be incorporated in this unit in the bottle chute door opening.

The selective drink dispenser produced by Automatic Canteen utilizes red Catalin for the letters forming the name across the top of the unit, for the three push buttons which give the patron his choice of freshly mixed carbonated beverages, and for the door lift where the cup is removed.

PHOTO, COURTESY BALLY MFG. CO.

In pin-ball machines, injection molded cellulose acetate is used for bumpers and hazards because of the material's resiliency and bright color

Adding punch to *Amusement devices*

A LARGE volume of plastic material—particularly cellulose acetate—finds its way into pinball machines and a wide variety of other types of games in which play is initiated by means of inserting a coin in the slot provided.

In earlier years, companies in this field worked out new components for each game introduced. Since new games must be offered constantly to supplant those in which interest is waning, it was found more practicable to standardize on cabinet sizes, electrical assemblies and other components, including the plastic bumpers, islands and posts used as obstacles in the field of play. These are usually injection molded in several basic colors, most of the output being handled by a small number of molders who work very closely with the game manufacturers and specialize in meeting their requirements.

Due to the standardization of parts, manufacturers can now change their lines of games almost overnight by working out new wiring hookups and modifying the arrangement of the bumpers and other obstacles. The cellulose acetate bumpers, which may consist of from one to several parts, are ideal for this application because they combine ease of molding, resilience and bright color with translucence, giving the playboard the necessary merchandising punch by means of bulbs, concealed under the brightly colored bumpers, which light up as the pinball contacts them in moving down and around the board.

Jackpot machines

Plastics are also being utilized on so-called jackpot machines, not only for such applications as lever knobs, but also to give the units greater visual appeal. One major supplier of this type of machine is using 10 low-pressure molded cellulose acetate panels on the front of the device, internally lighted by a number of small bulbs. Use of the colorful plastic inserts gives it greatly improved appearance over the prewar model, which had a plain metal case.

It is interesting to note that machines of this type are utilized by numerous clubs and fraternal organizations to underwrite their many charitable programs and fund raising plans.

ENJOYMENT WITH PLASTICS

COLOR in cold moldings

With these new compounds, heating cycle and baking period can be eliminated

by J. EARL SIMONDS*

COLD molding compounds have been in production here in America for about 40 years and have contributed in no small measure to the growth of the plastics industry. To these older cold molding compounds, usually classified as bitumen, synthetic or calcium hydrate-silica, have been added a new series, known as Moorex and Emco, developed by Frank J. Moore, technical director of Myler Plastics Corp.

The outstanding features of these new compounds, which are dry, granular, free flowing powders, are the wide range of brilliant, fast, opaque colors in which they are available and their ability to be cold molded automatically with no heating or after baking.

Starting from a white base any desired color can be produced although the material producer intends to market a standard line of colors in white, black, brown, dark red, blue, yellow, green and bright red. Other colors will, of course, be obtainable.

Paradoxical as it may seem these compounds may be either thermoplastic or thermosetting, formed cold with no subsequent baking or formed cold with subsequent baking. And no specially designed equipment is required in processing. Standard rotary and hydraulic presses may be utilized—the type depending on the area and cubic value of the article to be processed. For small articles up to $1^1/_2$ in. diameter the usual preforming rotary type press is used, giving a production of up to 30,000 pieces per hr. per machine. For larger sizes, up to 28 sq. in. in area, the single stroke press is used, giving a production of from 40 to 80 pieces per minute dependent upon area and volume.

Properties of the cold molding compounds

The specific gravity of the Moorex and Emco formulations range from 1.35 to 2.10. The powders have the same characteristics as many of the other general-pur-

* Plastics consultant.

1—*Colored pieces have been produced by the millions from the new cold molding powders on standard rotary preforming presses with no after baking. Only air blasting to remove powder dust was necessary for finishing*

COLOR PLATE, COURTESY MYLER PLASTICS CO.

2—A special formulation of these cold molding compounds is being tried out for thread spools and experiments indicate that the problem of notching on the flange can be overcome using these materials

pose powders now on the market, and they show a good to excellent resistance to heat, most chemicals, alkalies and common solvents. The compounds are non-toxic, non-poisonous, non-soluble in water.

The electrical properties for the most part are comparable to present available general-purpose plastic compounds as are the qualities of durability and strength, surface appearance and luster. At present there are about 40 formulations that meet a variety of particular specifications. Where specific qualities are required, special formulations can be made up to meet the needs of the end use product.

The sizes of the pieces which can be cold molded from the new Moorex and Emco compounds are presently limited by available equipment to the following:

Square pieces, to 28 sq. in.
Circular pieces, to 4 in. diameter
Rectangular pieces, to $3\frac{1}{2}$ by 8 in.
Thickness, to 3 in.

Any surface design can be used, and edges can be grooved or serrated. The material lends itself to drilling although holes may be formed during the molding operation.

The significant development in the end use manufacturing process is the fact that the *initial* or *preforming* operation in the hot compression method is the *finished* operation with the new compounds.

The parts illustrated in the accompanying color-photo give some idea of the uses to which the Moorex and Emco compounds can be put. They have been cold molded by the millions from these powders on standard rotary preforming presses with no after baking. The only operation necessary after the molded pieces were ejected from the machines was a dusting by air blast to remove any powder dust. Only when increased tensile strength is required of the parts is baking necessary. Where a very high luster or polish is desired tumbling or waxing processes may be used.

Suggested fields of application

The fact that these compounds are produced in dry granular form, in a wide range of brilliant colors and are being automatically molded at high speed and low cost, suggests their use in many fields not yet open to other types of plastics compounds.

As the result of an industrial and market research project the following articles should offer potential outlets for these compounds:

Handles, spools, knobs, ornaments, shoe heels, toilet seats, valve handles, fuse cores (household), bottle cap flanges, curtain shade pulls, rosettes, letters and numerals, game markers, mahjong, checkers, toy wheels, small pulleys, ash trays, coasters, poker chips, tokens and imitation coins, picture frames, doll heads, toy blocks and bricks, buttons, lamp bases, advertising plaques, small gears, coat hangers, jar and box covers, instrument housings, battery boxes, containers, wedgies, bicycle seats, wiring devices, tile.

Cold molded thread spools

The spools shown in Fig. 2 are an example of a part produced from a *made to order* formulation. With the increasing shortage of birch (the preferred wood for spools) and the scarcity and cost of lumber in general, spools seemed a natural outlet for these cold molded materials. Accordingly, the material manufacturer has initiated experiments which he has high hopes will solve the *nicking* or *notching* on the periphery of the flange of the spool, the great stumbling block thus far in the production of a plastic spool acceptable to the thread trade. A series of test runs on a standard thread winding machine resulted in 85 percent success in *nicking* the spool flange where the thread end was clipped in. Indications point to a solution of this problem after further developments are completed.

Electrically conductive compounds

Another experimental project is now under way on a low cost electrically conductive cold mold compound which can be formed into articles that will metal plate without a preliminary coating and without final burnishing. Of extreme interest, too, are recent tests which show that certain of these cold mold compounds can be molded *hot* on standard types of compression presses while others may be injection molded or extruded. However, further research determinations must be made before full data can be released on this procedure.

This new method should be looked upon as a supplement to existing methods of fabrication. Neither cold molding nor the new compounds are a *cure-all* for all types of plastic manufacture but in the fields where the methods and the compounds can be utilized they offer advantages which in the final analysis will bring about lower priced items and increased business.

1

Changing styles in iron handles

by J. H. DUBOIS*

THE electric iron has, for a long time, been a large consumer of plastics and the housewife has benefited greatly as engineers have sought to improve the utility and appearance of this most essential household appliance. Starting with molded substitutes for wood handles, the designers have made use of plastics in successively newer applications, moving along from wood substitutes to fully functional and beautifully styled handles providing a maximum of thermal insulation to the user's hand. New models yet to come will make use of silicone insulated heating elements.

Plastic iron handles cost much more than simple wood handles but amply justify their use by added product value. These multiple values include electrical and thermal insulation, wear and color stability, decorative and structural function, pleasing tactility and appearance, all of which combine to give maximum

* Executive engineer, Shaw Insulator Co.

1—The first molded iron handles were produced from cold molded compounds. 2—With improvements in the thermal construction of irons, it became possible to use phenolics in the handles. 3—A variation on early design was this form-fitting red phenolic handle. 4—Another departure from the usual was a design in which the handle had no front end support. 5—Indicative of the future was this iron handle incorporating a heel rest

utility and highest sales appeal. In fact, iron handles serve well to illustrate the versatility of plastics.

Handles of the early thirties

One of the first molded handles was produced by Mack Molding Co. in 1931 for the C. D. Wood Electric Company. This handle was a replica of the commonly used wood handles of that era and similar to that shown in Fig. 1. It is interesting to note that samples were produced and tested of phenolic and urea compounds.

Shown also in Fig. 1 are the heat-control lever and the plug casing on the Supermatic iron manufactured by Superior Electric Products Corporation. Cold mold compounds were used for these parts. This was a high temperature iron with no thermostat and capable of reaching temperatures far above the safe operating range of the phenolics. Cold mold insulation parts of this type were only fair in appearance but they did serve well under severe operating conditions. Nonrefractory cold mold compounds will withstand temperature up to 500° F. as against the 300° F. rating of the conventional woodflour phenolics. The underwriters tests on plug casings are severe and the cold mold compounds are still preferred for high temperature appliances.

During the early thirties, several manufacturers turned to the phenolics for the control lever, thumb rest and handle of their irons. The use of the phenolic instead of the cold mold compounds for the control lever was made possible by the improved internal construction of the equipment. Iron handles in this era were merely phenolic substitutes for the turned wood

6—The fact that the cord attachment could be made an integral part of the phenolic handle did much to extend the use of plastics in irons. 7—Another improvement in handle design came with designing of a part with an integral insulating pad. 8—By building a water filling funnel into the front pillar of this molded handle the operation of this steam iron was much simplified and the control is raised to a position where it remains cool. 9—Novel but useful is this compact traveling iron with a collapsible handle molded from walnut phenolic compound

variety of earlier years and a typical model is shown in Fig. 2. A variation of this handle was the form-fitting model molded from red phenolic by an Australian molder which is shown in Fig. 3. Then there was the interesting handle with no front end support as shown in Fig. 4, which was developed by the Dominion Electrical Manufacturing, Incorporated. This was molded in 1935 and contained a stamped metal insert held in position during molding by Rogers Board strips.

Handles no longer imitate wooden handles

The first real improvement in iron handle design was initiated by Alphonso Ianelli for Birtman Electric Company. This iron, shown in Fig. 5 and first described in the *Plastics Products* (forerunner of MODERN PLASTICS magazine) issue of August 1933, was far ahead of its time. Combining thermal insulation that was resistant to transmitted and radiant heat, a hollow and cool handle with integral support pillars, a heel rest, heat control recess and excellent functional styling, this iron paved the way for future developments.

The Westinghouse iron handle (Fig. 6) was the first to include the cord attachment and strain relief as an integral part of the rear pillar. Because this construction eliminates the plug, this feature has been widely adopted by the industry in various forms.

Chicago Flexible Shaft Co. has achieved the outstanding use of plastics in its Sunbeam Ironmaster. This very functional handle, shown in Fig. 7, incorporates the red phenolic control wheel in the handle. The design is such that the wheel is elevated where it is cool and readily accessible to the ironer. The body of

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10—This iron has a hollow handle transfer molded of general purpose phenolic. 11—A close-up of the handle for the iron (Fig. 10) shows how it is cored out in the center to facilitate operation of the elevating lever. 12—A steam iron which utilizes phenolic handle, water plug and funnel. Its connector plug is cold molded. 13—The handle for the steam iron shown in Fig. 12 was designed to cut molding expense to a minimum. 14—A series of multiple plates are used on this iron to reduce the transmission of heat to the plastic handle

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16

15—Taking advantage of the sharp parting line, the designer of this iron created a distinctive appliance. 16—Finger-tip control centered in the handle of this iron makes it easy to operate

this iron is insulated by an integral pad which helps to keep the fingers cool and guards against their being burned from contact with the top of the iron. This well styled model also makes use of the plastics handle as a heel for the end support of the iron.

The new General Electric steam iron has a water filling funnel with the control built into the front pillar beside the integral thumb rest. This arrangement, clearly evident in Fig. 8, greatly simplifies the job of filling the iron with water since the control remains cool in this elevated position. Another novel iron handle is the General Electric travel model shown in Fig. 9, which folds flat for portability.

Engineering the handles

The essential engineering considerations involved in all these iron handle designs have been solved in many ways. Air gaps are used extensively to reduce transmitted heat. This construction change reduces the amount of heat transmitted to handle and lever and made possible the full use of phenolic plastics. In some cases, multiple plates in series, as shown in Fig. 14, have served to keep the heat transmission at a minimum.

The general-purpose woodflour phenolics have been used most extensively to obtain minimum thermal conductivity. While mineral filled phenolics will withstand higher temperatures than general-purpose materials they also conduct heat more readily and all in all, are less desirable. Large heavy inserts with attachment slots are the most common front-end mounting devices; tapped holes, self tapping screws and inserts are used extensively for the rear end fastening.

The Steam Electric iron handle, in Fig. 13, was designed for minimum mold expense, the front mounting hole being drilled after molding. This mounting hole and recess is covered by the front end nameplate (Fig. 12), an arrangement that makes for very low-cost mold and part construction.

Early iron handles were often compression molded in two ram presses. The Chicago Flexible Shaft Company's handle is compression molded by Chicago Molded Products Co. in a split wedge mold with the force carrying the inserts into the underside of the pad. American Insulator Corp. produced this handle by the transfer process. The Proctor handle, (Fig. 11) shown mounted on the iron in Fig. 10, would be particularly difficult without transfer molding because of the double side cores that are required.

In styling the Waring iron (Fig. 15) Charley Jackson took advantage of the crisp parting line in the entire iron design and has achieved distinctive appearance. Many designers *peak* the parting lines of the handle so that its removal is unnecessary when the part is transfer molded. In this case, a knife cleaning operation and a wipe are all that are required in order to produce the part.

The Mat Matic iron handle shown in Fig. 16 is molded in a 4-cavity mold using a 250-ton clamp and a 75-ton transfer cylinder. Transfer time is 10 sec. and cure time one minute. Since the cored areas are elevated on trays by the knockouts and the pieces then ejected by auxiliary side cylinders, it is thought that maximum potential mold capacity is obtained for the first time in the molding of handles for electric irons.

A DIFFERENT approach to the problem of electric iron design is found in the Eureka Vacuum Cleaner Company's cordless model. Here the iron draws instant heat from brief electric contact with a thermostat-controlled electric safety base. The iron itself is not directly connected with the source of electric power.

A micro-heat regulator, built into the base, insures a close control over the temperature attained by the iron, insuring the use of the most desirable degree of heat for each type of fabric. Since this control in the base automatically switches current on and off, the danger of fire is said to be much reduced.

There are three plastic parts on each cordless units—the iron handle, the temperature control button and switch case. Both of these last named pieces are part of the safety base. In all cases, Bakelite is used for molding.

Extruded hose and shelf edging

Inside and out, extruded plastics are proving of real—and lasting—help to the housewife

APPEARANCE, wear and easy maintenance are the principal concern of every housewife as she shops for home equipment—whether it be for the kitchen or the garden. And these are the three qualities that combine in the extruded cellulose acetate butyrate shelf edging and polyvinyl chloride garden hose produced by American Extruded Products Company.

Colorful shelf edging

Marketed in four vivid colors of red, yellow, blue, green and in ivory and white, the extruded cellulose acetate butyrate edging is approximately 0.020 in. thick and $1^1/_2$ in. wide. The perforated design of diamond and angle shapes is stamped out in a punch press, after which the sheeting is cut into 3-ft. lengths and packed in a self-seller package.

The ease the plastic edging brings the housewife extends even to its attachment to the wooden shelf, for along the mounting edge of the strip, at about 3-in. intervals, are tiny holes just the size of the body of a small nail. And once the material is in place, the job of spring and fall cleaning is greatly reduced. Instead of ripping and tearing off all the edging, a common and necessary practice with paper trim, a damp rag wiped across the plastic cleans it so it looks like new.

Flexible, long-wearing hose

The garden hose has the same easy-to-clean feature to recommend it. But more important, is its light weight—6 lb. 6 oz. for 50 ft.—and long life. Developed during the war and widely used for oil and fuel lines in aircraft and ships, the Amepco hose is highly resistant to abrasion and shows almost no effect from weather aging, heat or cold.

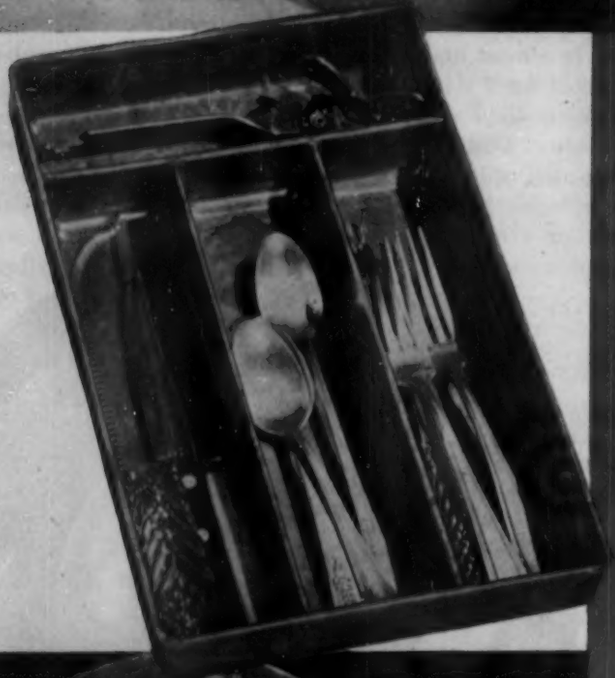
Tests run on this garden hose shows that there were no apparent signs of wear after a sample had been subjected to the action of a moderately stiff bristle brush, revolving at 600 r.p.m., for a half-hour period. Further, when a section was bent sharply through 90° at the rate of 100 cycles per minute, it showed only slight deformation at the point of bending after 100,000 cycles.

Designed for use with normal city water pressure, the hose was found in tests to have a bursting strength of 425 p.s.i. at 70° F. and 225 p.s.i. at 125° F. When tested for its reaction to solvents, the hose was found to be almost unchanged in appearance after being subjected for 2 days at 70° F. to gasoline, to 10 percent caustic soda and to 10 percent sulfuric acid, respectively. A sample tested for its reaction to 95 percent solution of alcohol stiffened slightly.

Extruded products such as this polyvinyl chloride garden hose and cellulose acetate butyrate shelf edging will be finding more and more application in the home as time goes on

← A coin a day keeps the wolf away and this little girl will have $30 when her Bank-a-phone is filled. The toy is molded of Lumarith in 32 pieces for the Du Page Plastics Co. by Eclipse Moulded Products Co. and Superior Plastics Co. Modeled after a coin-booth telephone, a bell rings as each coin is dropped. Adding to the illusion is a dial that clicks

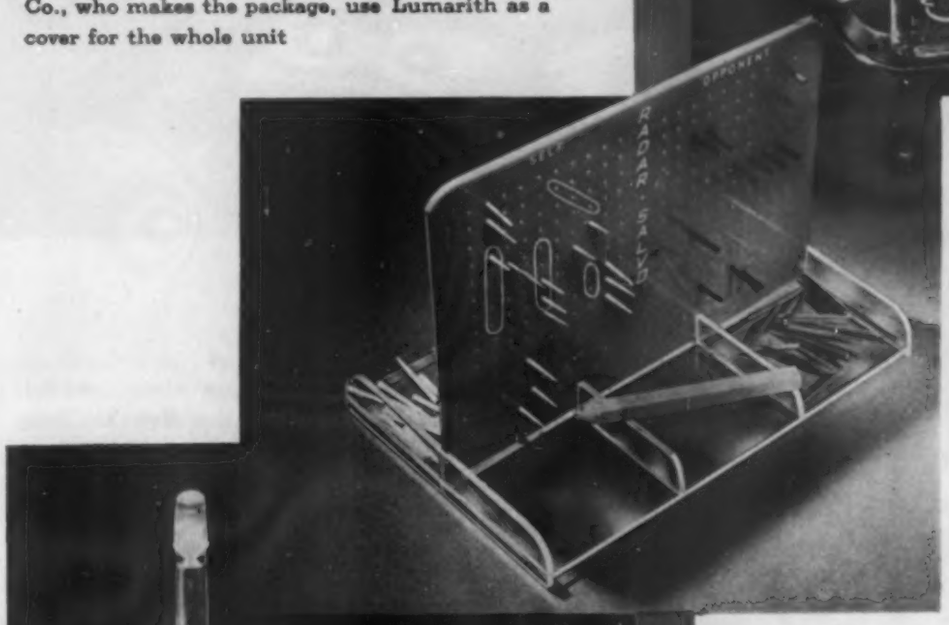
PLASTICS IN REVIEW



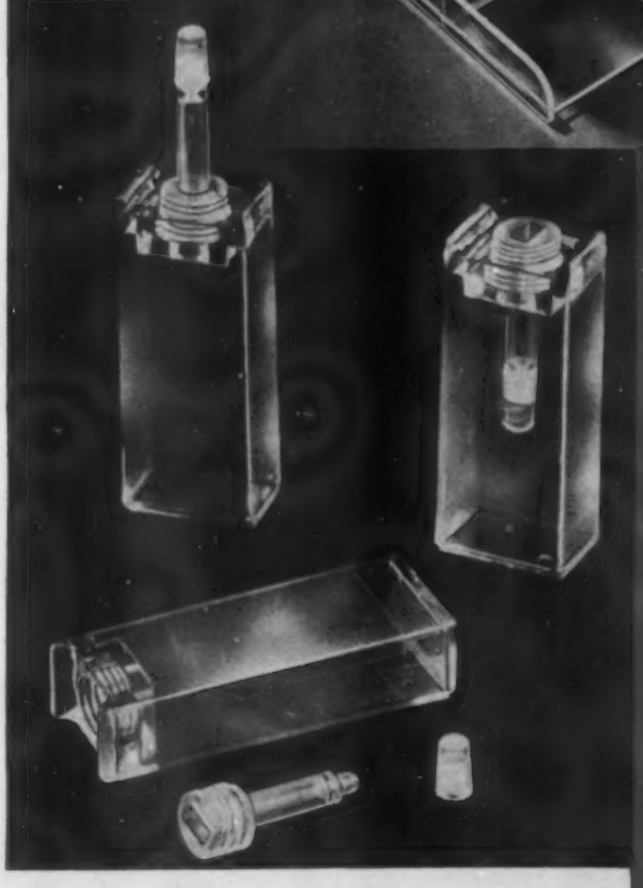
← Enthusiastic acceptance is reported for this compartmented "San-Duro" silverware tray recently placed on the market by Eclipse Moulded Products Co. The trays are injection molded of both cellulose acetate and polystyrene in a wide range of colors and mottled effects. Ribbed construction employed on the underside imparts pronounced rigidity to the tray, an important consideration because of the weight of the silverware it is designed to hold. The tray has four compartments

← This salad and hors d'oeuvres set has arrived just in time for the summer season with its hot-weather meals. In making the set, the Standard Products Co. starts with crystal-clear polystyrene to which it adds a bit of colored polystyrene to produce a mottled pearl effect. The pieces are then injection molded. The molder also distributes the sets which come in green, yellow, red and white. An attached label instructs the housewife on the proper care of this unique and different plasticware

Whirlpool and Bedlam are the gay names Alphonse gives his new toiletries packaged in plastics. The stands, fabricated of pink Lucite, serve as counter displays or ornamental holders on dressing tables. Made so they don't tip easily and with grooved sections into which the bottles fit, the holders, product of Transparent Container Co., who makes the package, use Lumarith as a cover for the whole unit →



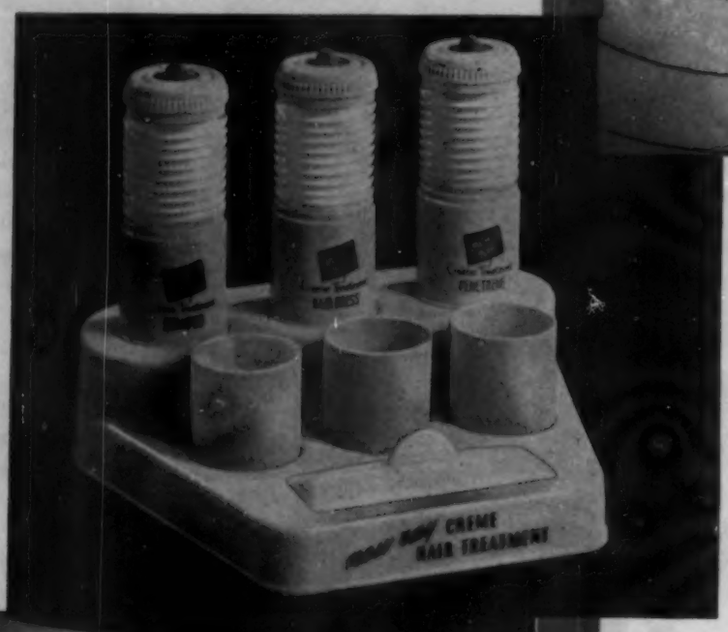
← Old tars will welcome this variation of the Battleship game called "Radar Salvo." Players sitting opposite each other mark the position of their fleets on their side of the opaque Plexiglas board. Opponents use pegs to knock rival boats out of commission. Transparent acrylic trays hold the pegs. Art Display Co. fabricates the board and tray for O. S. Wilkinson Company



← Small oil cans, usually in the gadget class, are now outmoded by this one which retains its small size without any reduction in efficiency. Cap, spout and container are molded of Lumarith and Tenite II by the Standard Molding Corp. The container is produced in a 2-cavity automatic injection mold with sets of cores for making the female threads. Other parts are formed two at a time in 6-cavity molds. Aside from its petiteness this oil can has the advantage of being transparent and lightweight

Organizing one's desk is a simple matter with this one-piece Plexiglas accessory. The fabricator, M. M. Gottlieb Associates, Inc., thought of everything when making it. The calendar—fully protected—is perpetual. There are wells for pins and clips, and writing paper fits snugly into a compartment positioned below a grooved pencil holder →

Jack of all trades and assistant to draftsmen, carpenters and mechanics, this instrument is designed for eight different drawing and measuring purposes. Here it is pictured against a background lined by the leads of the movable arm. Precision Plastics Co. molds the unit in two parts of yellow Tenite for the Parva Products Company. The material, which is tough enough to stand the hardest use, has the benefit of transparency →



← "Everything in its place" is the thought behind this New Ray hair treatment dispenser tray, a product of Raymond Laboratories, Inc. It has wells for dispenser bases, lotion cups, and one, with cover, for applicators. White Beetle is used for tray, other parts are molded of the same material in a number of pastel shades

← Among the handsomer household items that can be used for duty as well as for decoration purposes are Lucite trays fabricated and distributed by Almac Plastics, Inc. Here beauty lies in simplicity of form, care of workmanship and the delicacy of the hand-painted flowers. Some housewives may prefer to use the trays as plates for sandwiches or one may be used for cool summer drinks, or as an individual luncheon, breakfast or sickroom tray

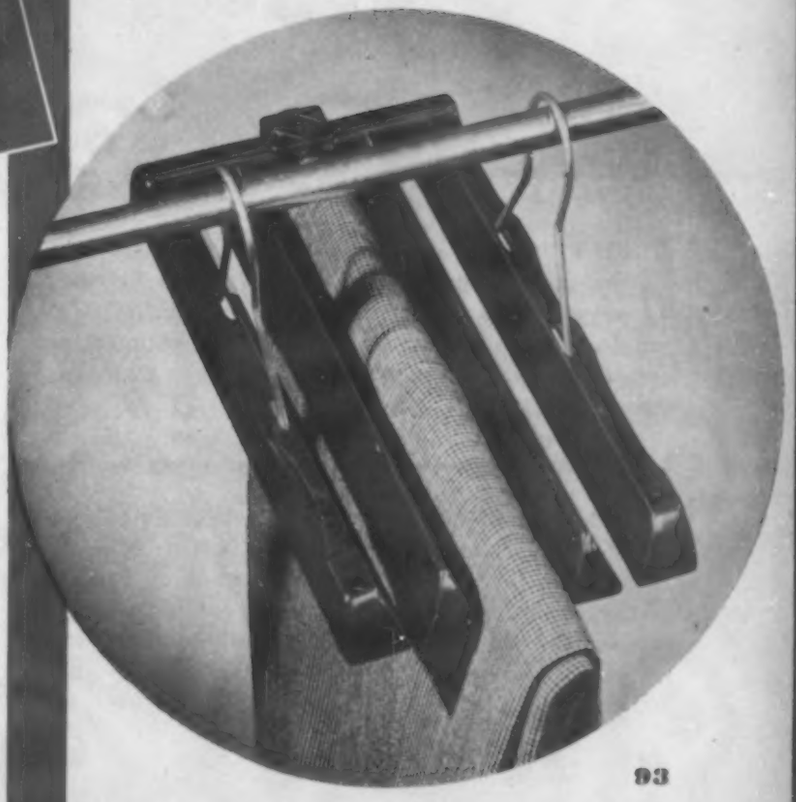
Plastic has been called on to do a clean-up job in factories. Placed in a Sjostrom Machine Company's magnetic floor sweeper, a sheet of Synthane holds on its bottom surface the metal refuse that has been picked up from the floor →

In 1947 when brand new car models roll off production lines, many will have Plexon robe and toggle straps. These straps, braided with resin-coated yarn, are resistant to hard wear and stain, are waterproof, and come in 120 non-fade colors. Rubin Trimming Co. processes the material and guarantees it against sagging and stretching →

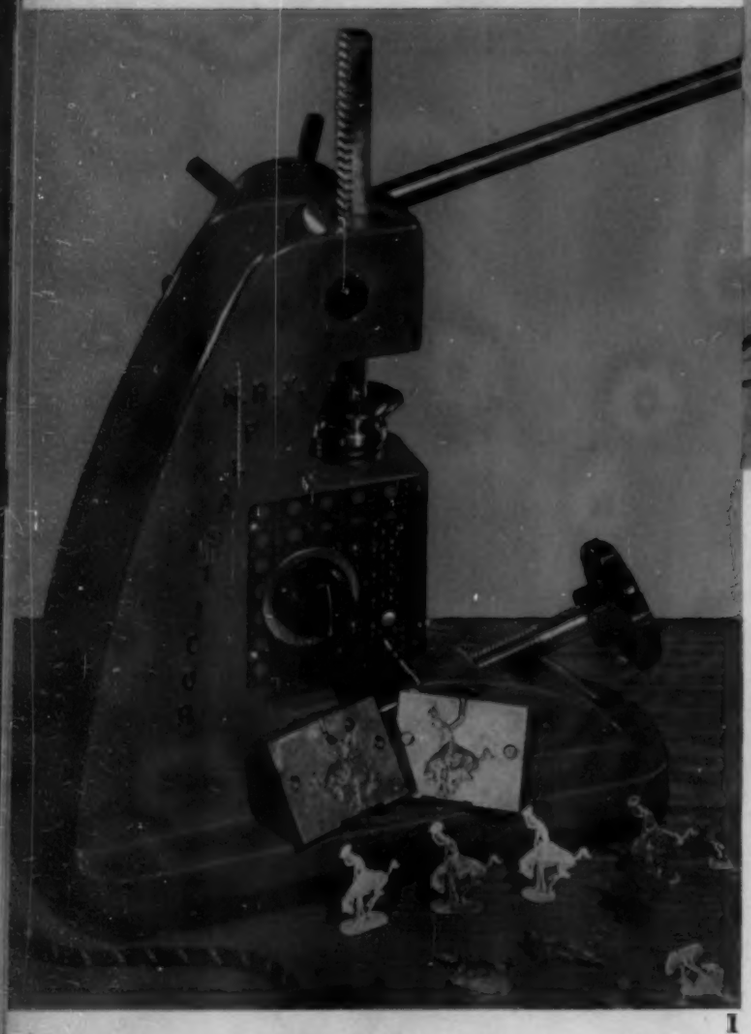
An illusion is effected by these handbags which look and feel like leather. But it is no illusion that they will withstand the hardest of wear and have no tendency to fade, crack or peel. The material, Kerazon, which is used for the bags, is said to be easy to tailor and stitch →

PLASTICS IN REVIEW

For the convenience of the gentlemen, Pioneer Products Co. has brought out a trouser hanger. Men will like it because it keeps the center crease in trousers, accommodates three pairs, with or without cuffs, and takes little closet space. The hanger is composed of five bars (three for hanging and two end pieces) which protrude at right angles from a connecting bar. Haas Corp. compression molds unit of Bakelite in one piece →



A boy's own molding press



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1—With a toy injection molding machine, enterprising lads can mold their own cellulose acetate toys. 2—First step is to feed plastic pellets into heated chamber

LIFE with father should be different from now on. Instead of digging deep in his pocket for the necessary coin to purchase the miniature cowboys and Indians, toy animals and train cars so urgently sought by the youngsters, he can tell them to make their own.

The miniature press and die-cast alloy molds

All this is made possible by the Plasticor, an educational toy machine designed by the N.R.K. Mfg. & Engineering Co. for the injection molding of Tenite. So easy is this unit to operate that an enterprising lad between the ages of 10 and 16 can easily manufacture his own colorful plastic toys—from the cowboys and Indians to club pins, buttons and buildings—even to supplying golf tees for the old man and his Saturday afternoon foursomes.

The Plasticor is constructed on the principle of a real injection-molding machine. It measures 12 in. in height, weighs approximately 17 lb. and is sturdily built. It is made of steel and alloy parts and has a heavy aluminum frame. A rubber pad on the base prevents the machine from scratching furniture so that it may be set up on the dining room table with impunity. Furthermore, since both the machine and the Tenite used for the moldings are absolutely clean, the operations can create no dirt or mess. The toy machine may be plugged into any 110-volt electrical outlet in the house—either AC or DC.

The machine is of the vertical type, with a $^{5}/_{8}$-in. hand operated plunger-type ram which has a stroke of $2^{1}/_{2}$ inches. When 50 lb. of pressure are exerted on the 10-in. operating lever, a pressure of 6000 p.s.i. is effected—remarkable for a machine of this size, considering the fact that large machines exert 14,000 to 20,000 p.s.i. to mold cellulose acetate.

According to the manufacturer, the pressure of the toy machine presents no hazard. When the mold is clamped into position on the bottom of the machine, there is not enough space between mold and nozzle for fingers to be caught. Manual operation assures additional safety.

Within 5 to 10 min. after the toy machine is connected

ALL PHOTOS, COURTESY TENNESSEE EASTMAN CORP.

3 4

3—Pulling down the plunger lever at top of the machine forces the plastic into a mold and the material starts to harden at once. A vice clamp, for holding the mold, is then loosened and the mold is released. 4—Opening two halves of the mold, a completely finished cowboy, astride bronco, emerges

to the electrical outlet, a temperature of from 375 to 400° F. is attained. The temperature is regulated by a rheostat. The heating cylinder is completely insulated with fireproof materials, and a safety guard surrounds the nozzle, protecting the operator from the hot cylinder. The unit is removable and can be replaced if necessary; but it is not expected to burn out any faster than a modern electric iron. This allows plenty of time for the boys—for the entire family in fact—to have a lot of fun molding a wide variety of cellulose acetate parts.

The molds used in the press are of a die-cast alloy. They are made in two halves and measure 2 by $2^1/_2$ inches. The mold slides into position at the bottom of the machine where it is held firmly in place by a hand-operated vise clamp. When the clamp is loosened, the mold slips out.

How it operates

Plastic pellets are fed by a measuring spoon into the loading chamber at the top of the heated molding cylinder. The hand-operated ram at the top of the machine forces the melted cellulose acetate into the parting line of the mold. The Tenite hardens immediately into a finished toy which is a faithful reproduction of the design in the mold, even to the smallest detail. The toy machine is capable of molding two shots per minute, with a completed plastic casting weighing about 0.3 oz. maximum. Maximum width and height of each one of the molded pieces is always the same—2 by $1^3/_4$ inches.

Merchandising the press

The toy machine retails for about $29 and it comes equipped with five separate molds, four $^1/_4$-lb. containers of cellulose acetate pellets in four colors, a pair of tweezers for removing the molded article from the mold, a measuring spoon and a long handle which may be attached to the spoked hand wheel at the top to exert additional pressure on the ram. More of the plastic and a wide variety of molds are obtainable from retail outlets for the Plasticor.

Molds for the making of buildings are sold in kits, with several molds to a kit, plus blueprints telling how many molded cellulose acetate bricks, window frames, etc., must be produced to construct, for example, a model of the Empire State Building. Solvent cement is provided for sticking the sections together. Kits of molds for bridges, planes, trains, farm buildings and animals are expected to be added to the line soon.

The development of this toy represents an entirely new approach to the use of plastics for playthings. Not only is the press a toy in itself but it can turn out toys in an endless stream, in a wide variety of colors and shapes to supplement the wide range of playthings, such as baby rattles and teethers, boats, soldiers, music makers, that have long been made of cellulose acetate.

A low-density structural core

by R. E. MAIER*

CELLULAR cellulose acetate, called CCA by E. I. du Pont de Nemours & Co., Inc., is an unoriented multicellular form of cellulose acetate developed primarily for use as the structural core material between two thin strong surface skins in low-density laminates.

The very small completely closed cells of cellular cellulose acetate provide a good surface for gluing and at the same time constitute a nearly continuous support for the surface skins in a laminate. The high softening temperature of 400° F. (due to the absence of any plasticizing ingredient) is a distinct advantage when the material is used with thermosetting resin adhesives in the fabrication of laminates.

To furnish a core with the strengths desired for various service requirements, CCA has been made available in any density in the range of 4 to 8 lb. per cu. ft. within a tolerance of ±0.5 lb. per cu. foot. The product is available in the form of extruded boards, the length of which is limited only by sizes of containers and method of shipment. Width and thickness, on the other hand, are limited by the nature of the extrusion process and the capacity of the manufacturing equipment. A semi-commercial unit is now producing material of widths between 4 and 6 in. and of thicknesses between ½ and 1 inch. Sheets and slabs of any size can be built up very readily from these boards by various methods of gluing.

Field of application

The use of CCA is usually justified for purposes for which its high strength and low density are essential. By reason of its cost it is not recommended for use in applications that require merely a thermal insulator or a space-filler. Laminated aircraft parts (e.g., floor panels, doors, tables and control surfaces), aircraft luggage[1] and artificial limbs are applications that make good use of the high strength and low density of the cellular cellulose acetate material.

Laminated ice-cream boxes, walk-in refrigerators, containers for frozen foods and refrigerated truck bodies are applications which utilize the low thermal conductivity as well as the low density and high strength of this material. Figure 1 shows a glued slab ready for use in refrigeration applications. The good acoustical properties of CCA laminates suggest its use in radio cabinets and sound equipment.

Physical properties

Comparative data[2] have already been published showing the high strength (tensile, compressive, shear and impact) of CCA compared to other core materials. That the strength of this material varies quite uniformly with the density is clearly evident in Figs. 2 to 6.

Preliminary tests have indicated that the mechanical properties are only slightly different at temperatures as low as −60 to −70° F. The high shear strength of CCA and the continuous supporting surface (see Fig. 5) which it provides for a laminate are outstanding advantages of this material over various grid or corrugated cores. As for impact strength, cellular cellulose acetate (Fig. 6) stands relatively high for an expanded plastic—superior to expanded phenol-formaldehyde and urea-formaldehyde and some of the expanded rubbers.

Other available data on physical properties are summarized in Table I. It is worthy of note that while cellular cellulose acetate is flammable in still air, the flame is readily extinguished by slowly moving air.

* Chemical Div., Plastics Dept., E. I. du Pont de Nemours & Co., Inc.

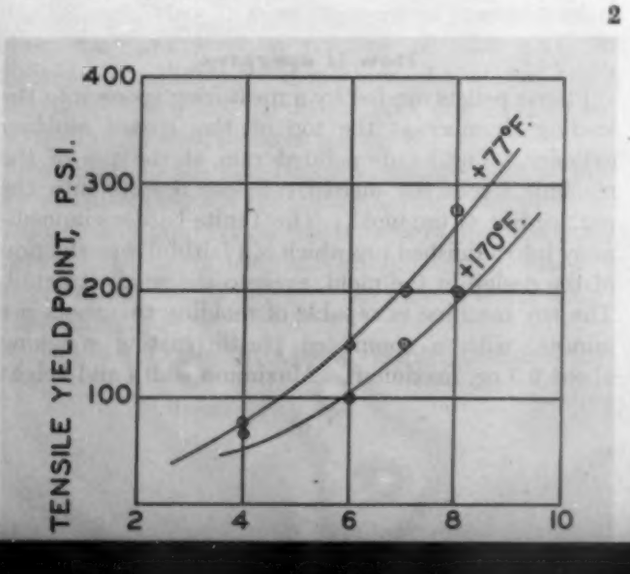
[1] "Structural materials made from Fiberglas fabrics," by John Reeves, Textile World *10*, 110–112, (Oct. 1945).
[2] "Core materials for sandwich structures," by Capt. G. B. Rheinfrank, Jr. and Capt. W. A. Norman, MODERN PLASTICS 22, 127–131, (July 1945).

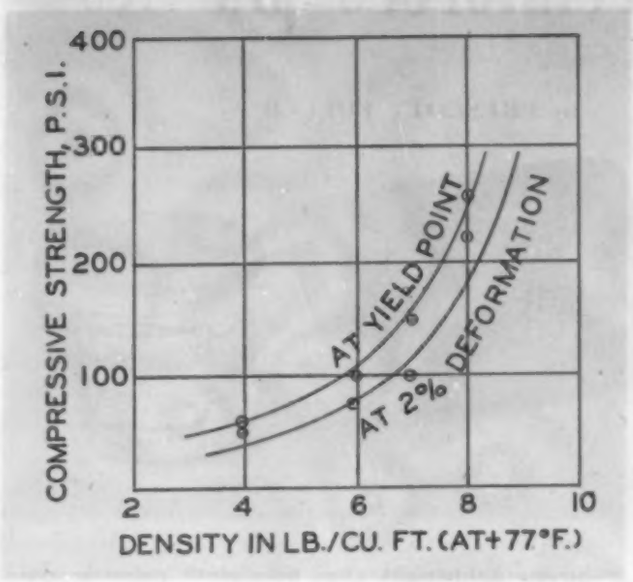
1—*Slab ready to be used in a laminated refrigerator*

PHOTO AND DRAWINGS COURTESY E. I. DU PONT DE NEMOURS & CO., INC. 1

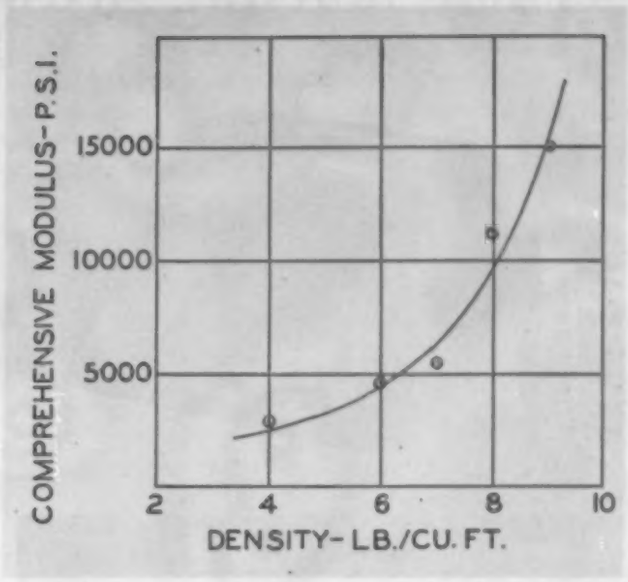
2—*Chart of relationship of tensile strength to density*

2





3—Chart showing compressive strength/density curve

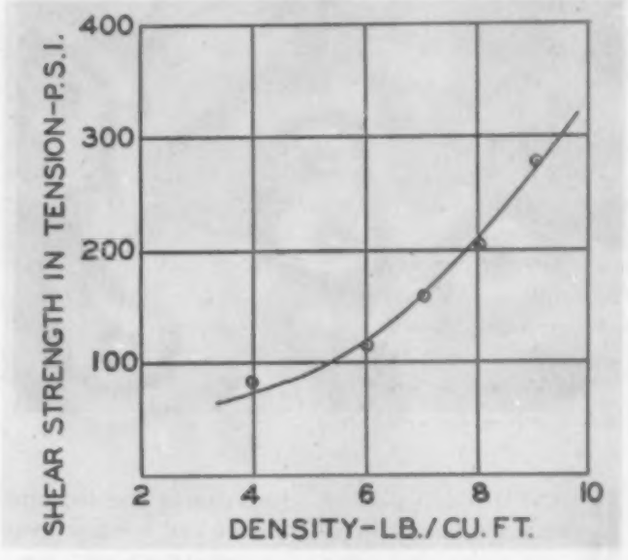


4—This chart gives compressive modulus/density curve

Machined pieces of any desired shape can be made by use of standard woodworking saws, planers, routers, shapers, drills and sanders. Thin strips with surfaces ready for gluing can be readily cut on a conventional bandsaw equipped with stops and guide block.

The material can be shaped with the aid of heat if it is heated throughout to a temperature of 395 to 400° F. Close control of the temperature is essential, however, because of the relatively sharp melting point just above the temperature at which it can be shaped.

Another technique of shaping requires no heat and at the same time increases the strength at the curved section. A series of parallel, wedge-shaped grooves is cut about three-quarters of the way through the material with a gang router fitted with cutters having a small included angle (about 10°). If the cuts are properly spaced and then coated with glue, the kerfs will close and weld together during the final lamination.

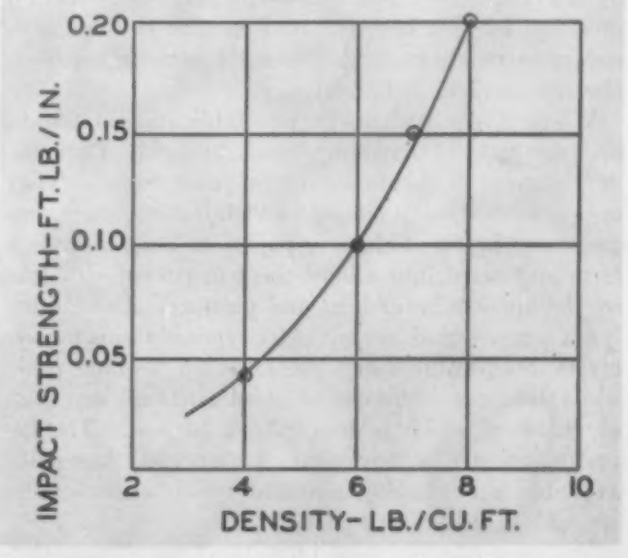


5—Here is indicated the shear strength/density curve

Table I.—Properties of Type CH-100 Series Extruded CCA

Property	*Test procedure*	*Type* CH-145	CH-167	CH-178
Density	..	4–5	6–7	7–8
Thermal expansion in in./° F.	[a]	.....	2.5×10^{-5}	2.5×10^{-5}
Moisture content at 50 percent RH, lb./cu. ft.	[b]	0.1–0.2	0.1–0.2	0.1–0.2
Moisture content at 100 percent RH, lb./cu. ft.	[c]	0.5–0.7	1.0–1.1	1.0–1.1
Buoyancy after 24-hr. water submersion, lb.	[d]	53.5	52.5	51.5
Thermal conductivity, B.t.u./ft.²/hr./° F./in.	..	0.3	0.31	0.32

[a] Direct measurement within the range of 77 to 170° F.
[b] Gain in weight from 0 percent RH to 50 percent RH.
[c] Gain in weight from 0 percent RH to 100 percent RH.
[d] A.S.T.M. D 570–42.



6—This chart shows the impact strength/density curve

Precision labeling with reinforced plastics

by PRESCOTT FULLER*

1

2

PHOTOS, COURTESY AMERICAN CYANAMID CO.

1—Strong lightweight glass fiber cloth polyester resin moldings are formed to contours of finished container. 2—These bottle holders will not warp or break in use

REINFORCED plastics which can be molded into curved shapes with low pressure and low temperature, are solving many problems in machine design. One of the latest developments in this field is the use, by the New Jersey Machine Corp., manufacturers of a precision labeling machine, of Fiberglas cloth—Laminac resin moldings for important functional parts on the company's Pony Labelrite.

Wartime requirements for new fabricating materials, and methods of handling them, brought about the development of thermosetting polyester resins. They are particularly well adapted to laminating, where impregnated layers of cloth or paper are built up over a form and cured into a hard sheet or curved structure by the application of heat and pressure. Laminating is not a new technique, but older types of resins require higher temperatures and pressures up to 1500 p.s.i., while these new resins can be cured with sufficient heat, at pressures which seldom exceed 30 p.s.i. The development and improvement of glass cloth has made available a reinforcing material which assures great strength in the finished part.

Precision labeling is of importance to all manufacturers of consumer products, particularly to those using glass packages. Unless there is a perfect register of the label and unless the label is fully glued down all around the edges, the impression of quality, which the manufacturer is trying to portray, may well be impaired.

To assure this type of label register, this labeling machine manufacturer uses a vacuum method in handling the label from the moment it reaches the hopper, in its short journey across the glue roller, until it is applied to the container. Other features are the twin roller method of glue application and the arrangement which enables the machine to handle all shapes and sizes of labels. But it is for label holders and container supports—called change parts—that laminated glass cloth low pressure resin parts are being produced. The label holders have enjoyed an unqualified success. The bottle holders, however, have been found to show undue wear after a sustained period of use and the molder is presently working on this problem and is hopeful of overcoming the difficulty.

Sales managers and their artists are always trying to create distinctive designs and shapes for their containers, and this desire has resulted in many labels that are exceedingly complex in the curves or angles of their edges. Also, the bottles themselves come in all forms and sizes. Some are short and squat, others are tall and gently curved. Consequently, parts which hold the bottle and labels while the machine is handling 60 containers per minute must possess channeled contours conforming to the design of the label or bottle. Each time a labeling job is changed, new parts are required if the label is of an irregular size.

Originally, hoppers were made of metal and, in some instances, wood. The disadvantage of metal hoppers is that they must be machined from solid stock and are very expensive. Wood parts, while less expensive, are subject to warpage and damage. The use of either material for change parts tends to nullify the economy.

* Plastics Div., American Cyanamid Co.

Investigation showed that Laminated Plastics, Inc., had a solution for the problem in their glass-plastic high strength laminates called Glastic. This company undertook the development of laminated designs for the New Jersey Machine Corp. parts.

Processing parts of reinforced plastic

The vacuum bag molding process was decided upon as the best means of producing the label holders and container supports. Heavy Fiberglas fabric impregnated with Laminac 4201 resin is laid up over wood and plaster forms shaped to the contour of the label to be handled. After assembly the material is placed in ovens or autoclaves for the necessary heat. Low, but sufficient, pressure for curing is supplied by the rubber vacuum bags. Reinforcement is included where necessary, and inserts for adjusting screws are molded into the Glastic laminate.

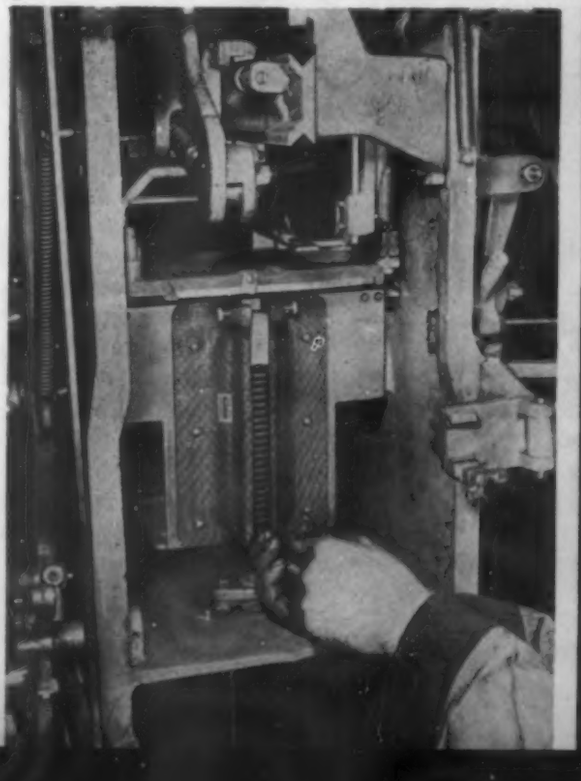
The primary reason for the selection of this thermosetting polyester resin was its high viscosity. This property means that the resin will remain in the cloth during the lay-up and not migrate during the curing process. Also, the resin contains no volatile component which will evaporate at room temperature.

Glass reinforced plastics were the answer to the need for durability and economy, without the sacrifice of the precision which is so essential to labeling machinery. The principal reason was the ease with which these high strength laminates can be formed to complicated contours in small lot runs without incurring prohibitive die and mold costs. The resultant part is light in weight, as strong as aluminum, chemically resistant and accurate to very close tolerances.

There are undoubtedly a great many locations in modern machinery where glass cloth reinforced plastic parts can advantageously replace other materials now used. In the packaging application described in this article, efficiency and strength were maintained, appearance improved and more economical production achieved. These versatile new materials should be of interest to manufacturers of machine tools, printing presses, other types of packaging machinery—in fact to every producer of mechanical equipment. Not the least important feature is the fact that these materials can be designed, manufacturing problems worked out, molds built and finished parts delivered very quickly.

3

5



4

3—Low pressure laminated parts molded in many complex shapes serve as label holders and container supports. 4 and 5—These holders and supports can be interchanged to accommodate the different shaped bottles and labels

The halves of the streamlined cellulose acetate housing are injection molded in 4-cavity molds designed with stripper plates rather than knockout pins. The only finishing operation necessary is removal of the gate

From trim-tab motor to hand mixer

THE products of the war are sometimes hard to recognize. Take, as an example, the small but powerful electric mixer now in production at the A. C. Gilbert Co. plant. This unit, which has sufficient power to mash potatoes and mix heavy gravies, might never have been developed but for the knowledge derived from the building of a little motor to operate the trim tabs on a Curtiss-Wright warplane—a motor which is the heart of this new civilian product.

The history of the development of this motor, which has a free speed of 20,000 r.p.m. and an input of only 20 watts, is worthy of retelling. Early in the war, the Curtiss-Wright Corp. presented the Gilbert engineers with the problem of designing a small trim tab motor. Within three days these men had removed a motor from one of their toy locomotives and equipped it with a gear box producing the required speed.

Approval of the design was immediately forthcoming and, over a short period of time, 20,000 units were shipped for plane installation. However, as airplane designs changed, the Curtiss-Wright Corp. required a more powerful motor. It is this powerful redesigned little motor which has now been adopted to the home mixer.

Adjusting for civilian use

For civilian use, the fields of this unit were rewound for 110 volts instead of the 24 volts used in airplanes. Further, it was enclosed in a two-part cellulose acetate housing, and equipped with a gear box with a speed ratio of 8 to 1. Provision of a worm drive made possible the operation of the beater at right angles to the movement of the motor.

The housing, designed by Harry Prebble, Jr., is a streamlined unit which fits the hand perfectly. The provision of vents permits forced circulation of air.

A 4-cavity mold is used to produce each half of the housing, the molds being run in 12-oz. Lester injection machines. The molds are designed with stripper plates so there is no problem with knockout pins.

Producing the commutator

Another interesting feature of the manufacture of this motor is the manner in which the commutator is produced. A copper shell, with approximately the same outside diameter as the finished commutator, is cut into $^3/_8$ in. lengths. The die used in cutting this shell is so designed that projecting ears are left on the shell after it is cut. In the case of the commutator used in the mixer, seven symmetrically spaced ears project from each side of the shell. These ears are bent down and inward so that they will permanently anchor the shell to the molded phenolic tube.

To produce this commutator, the shell is used as an insert in a standard compression mold, and a hole molded in the center to provide for assembly of the molded part on the rotor shaft. When the piece was first produced, difficulty was experienced in holding center hole and outside of rotor shaft to size.

Finally, a rather unique solution to this problem was evolved. A tube of phenolic impregnated paper is used as an insert on the pin which produces the hole in the center of the commutator. When molded, this paper compensates for the variation in the size of the knurl and removes the excess strain on the phenolic material in the case of an oversize rotor shaft. To complete the commutator it is only necessary to slit the copper shell into 7 uniform segments, grind the outside diameter and assemble unit on shaft.

Left—The heart of this hand mixer is a small motor, with a free speed of 20,000 r.p.m. and an input of but 20 watts, which was originally developed early in the war to be used for operating plane trim tabs

Below—To convert this mixer's motor from war to peace it was only necessary to rewind unit for 110 volts, enclose it in a 2-part cellulose acetate housing, equip it with gear box and a worm drive which permits the operation of beater at right angles to motor shaft

ALL PHOTOS, COURTESY A. C. GILBERT CO.

S.P.I. third California conference

The Annual Spring Conference of the S.P.I. in New York and the Plastics Exposition are reviewed on page 109

TEN panel discussions were the feature of the Third Annual Spring Conference of the Society of the Plastics Industry held in Hollywood, Calif., on March 26 and 27, and attended by 300 or more delegates from the industry. The formal opening was preceded by a preview of a comprehensive plastics exhibition assembled in the State Building, Exposition Park, where over 100 firms showed partly processed and finished plastics products. The exhibit, planned by Horace Blackman, Calplasti Corp., will be on view for several months.

At the business session, held on the second afternoon, the following officers were elected for the coming year: chairman, Robert A. Cooper, Plastic Die & Tool Co.; vice-chairman, R. B. Gutsch, Allied Appliance & Plastics Co.; treasurer, D. C. Severance, California Plastic Moulding Co. The Board of Directors includes: Herbert G. Pratt, S. T. Dahl Co.; Raymond J. Lambert, Monsanto Chemical Co.; John Delmonte, Plastics Industries Technical Institute; Merle Barron, Durite Plastics, Inc.; J. A. Carmien, New Plastic Corp.; Frank Moss, E. D. Bullard Co.; L. W. Schatz, General Plastics Mfg. Co.

The following paragraphs are a digest of the material presented at the 10 panel discussions and in the other speeches:

European developments in molding

Dr. Gordon M. Kline, National Bureau of Standards and Technical Editor of MODERN PLASTICS magazine; *William Goggin*, manager, Plastics Development Div., Dow Chemical Co.:

Dr. Kline's very detailed description of German methods of producing plastics can perhaps best be covered by referring the reader to articles that have appeared in MODERN PLASTICS each month since November 1945.

Mr. Goggin pointed out that German processing was markedly affected by the fact that the production of basic plastic materials was largely in the hands of one company, I. G. Farbenindustrie A.-G. Extrusion, compression molding and sheet work were notable for the large size of the pieces produced. Injection molding, on the other hand, was largely confined to items that were smaller in size.

Plastics in the textile field

D. S. Plumb, Monsanto Chemical Co.; *King Tate*, National Plastic Products Co.; *Dr. George Brother*, Western Regional Lab.; *G. A. Fowles*, B. F. Goodrich Chemical Co.; *Mrs. J. Taylor*, Jane Taylor Buying Service:

The applications of synthetic resins in the textile industry were divided into the following six groups: plastic fibers, plastic yarn sizing, plastic impregnants, plastic finishes, coatings, film.

As for outlets, as fabrics woven of vinylide chloride stand today they are well suited to upholstery in all types of conveyances, restaurants, hotels, homes and for linings in handbags.

Synthetic protein fibers prepared from milk, soybeans, peanuts and corn are likely to play an important part in the future of textiles. Being high polymers with long-chain molecules, they incline to low wet tensile strength. Cross-linking agencies and treatments are being explored with a view to improving textiles made from these protein fibers.

Plastics in building construction

Paul Hunter, A. I. A.; *A. Makintosh*, Structural Engineer; *J. Cunningham*, Short Wave Plastic Forming Co.; *Lewis N. West*, Wilson & George Meyer & Co.; *Joseph Schulte*, Res. Director, Fritz-Burns Co.; *Richard Oglesby*, Rohm & Haas Co.:

Plastic sales engineers are now finding that careful presentation of all qualities of materials is vital in serving the building field. In this way misapplication may be avoided and the industry will make better progress.

Synthetic resin adhesives have brought about a completely new form of wood construction, making possible better building in less time and at low cost. Increased fire resistance, prevention of decay and greater strength are anticipated. High frequency bonding of resin adhesives offers great advantages in time saving, handling of materials, cost of fabrication and improvement of structural qualities.

Molded articles such as bathroom and kitchen fittings, knobs, etc., have found favor with the public even when more expensive than wood or metal. Extruded trims (for both building and vehicular uses) and plastic tubing are being more widely used. Screens of synthetic monofilaments are gaining acceptance.

The postwar house designed by the Fritz-Burns research division together with Walter Wurdman and Weldon Beckett showed that simplicity of line and surface, and ease of maintenance bring plastics into the picture.

Transparent acrylic, being light in weight and optically good, can be used to advantage in construction, and, having thermoplastic properties, allows for freedom in designing which few other materials offer.

Stability of compression and injection moldings

Dr. R. Shuey, Bakelite Corp.; *Sven Mozness*, Minneapolis-Honeywell Regulator Co.; *A. R. Olsen*, Hercules Powder Co.; *Gordon Brown*, Bakelite Corp.; *Ward Jackson*, Celanese Plastics Corp.; *Horton Spitzer*, Plaskon Div., Libbey-Owens-Ford Glass Co.; *Donald Gibb*, The Dow Chemical Co.:

Dimensional stability must be discussed in relation to design, to material characteristics and to function if it is to have meaning. Closer tolerances are possible today than ever before but these close tolerances add to the expenses of molding. A good part of the discussion was devoted to the detailing of facts on dimensional stability of the cellulosic plastics, phenolics, urea and melamine. In the cellulosics, ethyl cellulose has the greatest stability; a specially formulated cellulose acetate comes second; cellulose propionate, third; cellulose aceto-butyrate, fourth; and regular cellulose acetate last. Phenolic moldings stand up to a wide

variety of environments. Phenolic binocular bodies stood up to extremes of test. Urea and melamine moldings are versatile in ability to hold shape, and melamine will retain stability at continuous temperatures of 210° F.

Low pressure laminated structures

W. I. Beach, Kaiser-Frazer Corp.; *B. Goldsworthy*, Industrial Plastics Co.; *H. Kline*, Reichhold Chemicals, Inc.; *Erwen White*, Owens-Corning Fiberglas Co.; *H. R. Jenks*, National Research & Manufacturing Co.; *C. Sachs*, and *L. Haupt*, consultants; *Foster Luce*, Evans Products Co.; *K. Woodson*, Permalite Plastics Company:

High strength reinforced plastics are tough, light in weight, resilient, non-corrosive, vibration dampening and insulating, so they offer industry wide opportunities. Now, the effects of new surface finishes, better mold releasing agents and higher quality tools are being felt.

The difference in water resistance and mechanical properties between high and low pressure phenolic laminating has been narrowed. In the future, more color variety in plastic overlays or skins for laminations are expected.

Industrial casting of plastics

Dr. K. Leeg, Consultant; *L. Wilson*, Duorite Co.; *C. L. Wurdeman*, Rezolin Co.; *J. Runkle*, Catalin Corp.; *E. Graham*, Durez Plastics & Chemicals, Inc.; *J. C. McCauley*, Walker Plastics Co.:

Cast resin jigs and fixtures have been used in industry only recently and laminated tools of this type are quite new; both are useful. New developments include flexible mold materials, faster catalysts and bubble-free casting resins. Fast curing phenolic resins with low mold shrinkage make possible speedy and economical prototype production.

Recent developments in molding equipment

George Cooper, Plastics Tool & Die Corp.; *Wm. Dewar*, Plastics Institute; *Sven Moxness*, Minneapolis-Honeywell Regulator Co.; *V. Eloonin*, Airtronics Mfg. Co.; *S. Kipp*, Sinclair-Collins Co.; *H. DuBois*, Shaw Insulator Co.; *F. Bunker*, F. J. Stokes Machine Co.:

Plastics, competing with low-cost light metals, must be produced on even more efficient machines. Recent developments include a combination injection-compression-transfer unit, a screw type injector for large charges, better lubrication, more efficient safety gates, better temperature controls, larger injection presses, conversion units for transfer molding on compression presses, more versatile electronic preheaters and air actuated valves for hydraulic presses.

High polymer adhesives

H. Kline, Reichhold Chemicals, Inc.; *D. Redfern*, Adhesives Products Co.; *Dr. George Brother*, Western Regional Lab.; *George Gordon*, National Research & Mfg. Co.; *R. Ernst*, Eronel Industries; *E. Graham*, Durez Plastics & Chemicals, Inc.:

Bonding resins need not be penetrating; laminating resins must be. One of the most interesting developments in phenolic resins in recent years is the use of resorcinol to produce resins that are extremely fast curing at elevated temperatures and also capable of curing even at room temperatures in about 5 hours. Polyester resins also offer new possibilities as do phenol-rubber combinations.

Forming of plastics

B. Thompson, Paramount Studios; *J. Parker*, Stack Plastics Co.; *M. Gill*, Peerless Plastics Products Co.; *W. I. Beach*, Kaiser-Frazer Corp.; *J. Williamson*, Formica Insulation Co.; *Roy Davis*, Plastics Institute; *C. K. Castaing*, C. K. Castaing Studios:

The latest techniques in free blowing and blow forming of acrylics and in postforming cellulose derivatives, phenolic laminates and polyester laminates have opened up new application possibilities. Bending dies for compound curves, better tools and closer control in production have meant improved products at lower cost.

Merchandising plastics

Donald Gibb, Dow Chemical Co.; *Ward Jackson*, Celanese Plastics Co.; *Don Belding*, Foote, Cone & Belding; *Mrs. Stella S. Alkire*, J. W. Robinson Co.

A significant note is that plastics are losing their novelty. The name will no longer sell the product made from it and misapplication can do the industry serious injury. The business is due to become competitive again, and to compete we must design soundly, engineer correctly, manufacture economically, package attractively and sell thoroughly.

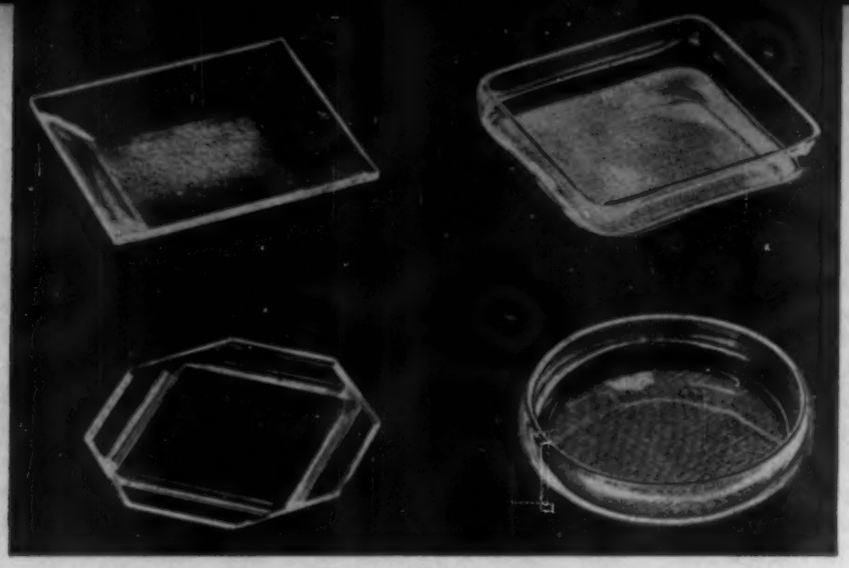
Individual sessions

The luncheon on March 26 with *James D. McDonald*, McDonald Mfg. Co., as toastmaster, was addressed by *Dr. Gordon M. Kline*, who spoke on the subject of "New material developments." Conference chairman, *Ralph P. David*, Pacific Plastics magazine, welcomed the delegates. Dr. Kline discussed the following materials which have appeared since 1939: resorcinol-formaldehyde, melamine-formaldehyde, silicons, furanes, unsaturated polyesters, polyethylene, styrene copolymers, polyvinyl carbazole, vinyl dispersions, cellulose propionate and both sandwich and foamed plastics.

Dinner on March 26, with *Fred L. Kennerley*, American Molding Co., as toastmaster, was addressed by *Neil O. Broderson*, president of S.P.I. on "Plastics faces the future;" *Wm. T. Cruse*, executive vice-president, S.P.I., on "The industry's record;" *Gordon Brown*, Bakelite Corp., on "What is going to happen to the plastics industry?" *N. J. Rakas*, Chrysler Corp., on "Plastics in the automotive industry;" and *Charles A. Breskin*, MODERN PLASTICS magazine, on "Problems vital to the industry." Mr. Breskin emphasized the peacetime challenge to sell—urging good management, better products born of the courage to use plastics only when they are functional and economical, good policies, a sound sales organization, good merchandising and advertising.

Luncheon on March 27 with *Roy L. Peal*, Plastic & Die Cast Products Corp., as toastmaster, featured a style show by Celanese Plastics Corp., and an address on "The vital role of industry organization" by *J. A. Hartley*, National Assoc. of Manufacturers.

The banquet on March 27, for which *Frank Wilcox*, Wilcox Plastics Molding Co., was toastmaster, had as speaker *Col. A. R. Heron*, Director, California Reconstruction and Re-employment Commission. The subject: "Jobs for industry."



VARIETY is the spice of life and therefore an essential of home accessories. That is why a method of forming acrylics developed by C. K. Castaing of C. K. Castaing Studios, promises such wide application for it produces—by blowing—shapes with undercuts.

The new technique, upon which patents are pending, is based on the principle whereby fluid pressure applied against a thin sheet of rubber gives a perfect spherical shape. Similarly if a piece of heated Plexiglas is held against a hole through which fluid pressure is forced, the shape taken by the acrylic material will likewise be spherical.

The size and shape of the article produced in this way is determined by three main factors: 1) temperature to which the acrylic is heated, 2) shape of the opening in the forming plate and 3) amount of fluid pressure used. Thickness of the material is another factor.

In making a round bowl with undercut sides, a top plate is prepared with the proper opening. This plate is set on supports whose height corresponds to the desired depth of the bowl, and the heated acrylic set on the top plate and clamped in place. When the right amount of fluid pressure is applied the acrylic takes the desired shape. After a few minutes for cooling it is ready to be taken from the plate and the edges finished.

Chief advantage of this technique is that articles may be produced without seams yet with an opening smaller than widest part of article. Pieces at left in picture are formed by usual methods.

PLASTICS

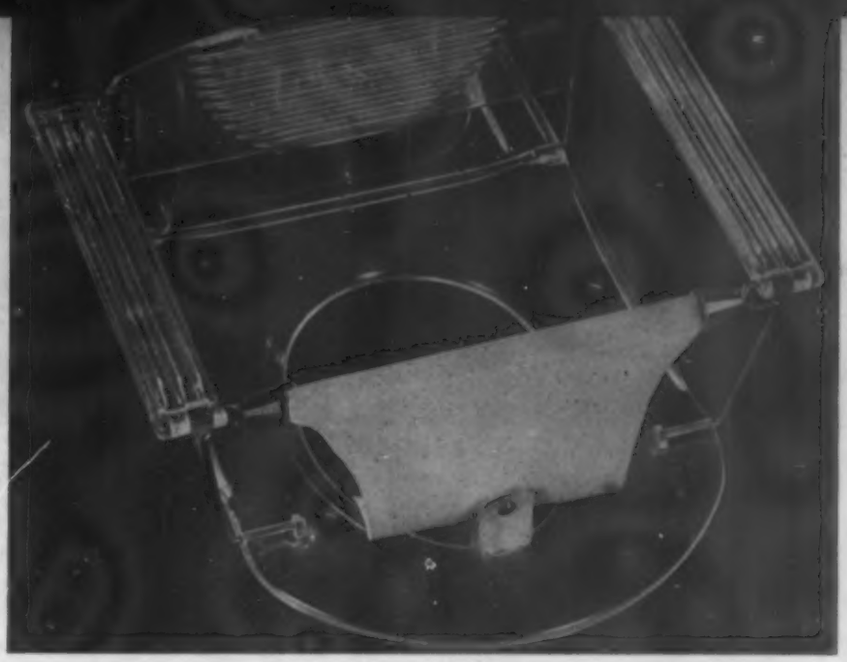
YOU'RE sitting pretty with a Gem-Weld air cushion designed to soft-pedal hard chairs and make reading in bed more of a pleasure than ever. Made from sheets of Vinylite cut in a variety of shapes, cushions and pillows are electronically heat sealed along the edges by a method born of wartime necessity and used in the manufacture of desalter bags for the U. S. Navy.

After the pieces that comprise each bag have been cut to size, the matching edges are positioned for sealing in a specially adapted high-frequency machine. By this means an all-through weld is produced that permanently fuzes the edge surface of the material and does away with the need for solvents which might impart an odor to the finished product. Seams formed by this process are air- and water-tight as is the vinyl material itself which also enjoys a high resistance to acids, oils and mildew.

A noteworthy feature of the cushions is that they inflate with ease yet, when deflated, are flat enough for storing in bureau, suitcase or even handbag.

For increased versatility, the air cushions are produced in a number of styles to suit a wide range of tastes and needs. There are some that are wedge-shaped, some that are shaped like a lifesaver and others that are rectangular. These last named are specially designed to give maximum sitting comfort by maintaining the balance of air in the cushion.

An afternoon spent on hard wooden grandstand seats at a football game or on a long trip in the car will be more comfortable thanks to the circular cushion. The flat rectangular style is particularly suited for persons allergic to down pillows, while the wedge-shaped pillow will win the acclaim of those who read in bed or on the beach where a back support is hard to come by.



THE trials and tribulations of an exasperated young engineer, who found by experience that his baby's awkward, conventional type toilet seat was never in position when needed, resulted in the development of Cher-Chair, a new infant seat, being injection molded of clear Bakelite polystyrene by Chicago Molded Products Corp. for the Dunrich Company.

Always in place, yet never in the way, the kiddie seat weighs less than 2 lb. and is only $^{3}/_{8}$ in. thick when folded. Attached firmly to the regular seat, it folds out of the way at the touch of a finger and can be swung back easily.

In the clear material of which it is molded, this new item blends unobtrusively with the color scheme of any bathroom. The obvious sanitation features of the plastic material, which is unaffected by water or acids, are augmented by the fact that the warm smooth surface is kind to tender baby skin. Stainless steel supports on the chair arms contribute to sturdy construction, as do the replaceable belt-guard and washable rubber deflector.

Parents who travel with children will welcome the attractive luggage-type carrying case, only $1^{1}/_{2}$ in. thick, in which the seat is packed. The chair need not be attached to adult seats in public places. The brace hook is merely folded out of the way.

PRODUCTS*

STRIPS and stripes of fabric woven from plastic-coated Plexon yarn make long-wearing, easy-to-look-at upholstery for furniture and coverings for books, screens and lampshades. Or the material can serve as seat and back webbing on occasional chairs.

Inherent in the fabric are the advantages found in the yarn from which it is woven. This yarn, which may be plastic-coated cotton, rayon or silk, served the Army as insect screening in the tropics, where it was subjected to high humidity, baking sun, hard rains.

All this adds up to the fact that furniture using this type of fabric has a definite place in the modern home, particularly for summer use or in localities where a good deal of outdoor living is possible all year round. And not the least endearing feature is that dirt blown onto the porch or in through open windows can be easily wiped off with a damp cloth.

Although it is stable and holds its shape without stretching and sagging, furniture manufacturers find the fabric pliable and easily handled, giving the designer a free rein in working out modern ideas. The material shown in the accompanying illustration is produced by Merlang Mfg. Company.

Well suited to the trend toward gay interiors and casual living are the bright colors in which this Plexon fabric is made up. For instance, the decorative 2-in. webbing is available in solid colors such as brown, yellow, red, dark and light green, while later offerings will include patterned and multi-colored webbing. The wider striped fabric comes in a variety of pleasing multi-striped combinations.

* Reg. U. S. Patent office.

TO ASSURE your looking "in the pink" what could be more logical than cosmetics in a pink plastic container? Such a thought may well have been in the minds of Elmo Sales Corporation designers when they planned the packaging for the company's line of Photo-Finish make-up.

The containers for all of the products except the make-up remover are compression molded of Plaskon urea. The crème and cake make-up boxes are, however, also injection molded of Tenite. The 4-oz. jar for the remover is compression molded of Plaskon melamine by Norton Laboratories, Inc., who use separate molds for the base and the cover. The engraved lettering, which is molded in the cover of the jar, is filled with gold lacquer.

This company also molds the face powder box, the cover for the lipstick and the containers for both the crème and cake make-up. The small cases for the two types of rouge, the cream and the dry, and the hinged two-compartment box for mascara are produced by the Plastic Molding Corporation.

There were several reasons for the adoption of plastics. In the first place, plastics have two features which glass, the conventional material for jars of this type, does not. They are light—a boon to travelers—and they are durable and will not easily break. In addition, plastics can be produced in soft pastels.

PLASTICS

BETTER tasting beer, purer beer and easier draw are just a few of the reasons why the all-plastic Kler-Flo beer faucet put on the market by Strong Manufacturing Co. is meeting with bartenders' approval.

All parts of the new beer tap are produced by Auburn Button Works. Most of them were formerly made of metal. The clear amber parts, including spout and washers, are injection molded of Plexiglas, the seat being molded as part of the body to eliminate leaks. Polystyrene is used for the knob.

The white portions of the faucet, which comprise the lower part of the knob stem, the neck of the faucet and a ring between spout and knob, are injection molded of rigid Vinylite, this material having the tensile strength needed for these moving parts. The ball inside the faucet which controls the flow of beer is made of Neoprene.

The switch from chromium-plated brass to plastic has been in all respects a change for the better. One principal advantage was visual sanitation. In the new faucet, the beer may be watched as it flows and any dirt developing in the coils can easily be detected. Further, the acid in the beer was found to corrode the brass faucet, a condition that might lead to a toxic condition if the unit was not entirely clean. With plastics this condition is remedied. Another advantage was found in the comparative shipping weights of the old and new types of tap. Where the metal one tipped the scales at $2^1/_2$ lb., the plastic unit weighs in at 8 oz.

The detachable polystyrene knob, where state laws allow, can serve as an advertising specialty and be supplied free of charge by the beer producer. This item is supplied with the name of the beer company engraved so that the wording, magnified on the side facing the customer, is hermetically sealed against moisture.

The construction of the tap is such that the spring creates enough tension to hold the faucet open for a continuous draw. Since there is nothing to "crack" the beer, it has better flavor.

FOR lighter moments in the busy executive's life, Ellis Manufacturing Co. presents an imposing Catalin desk or table lighter appropriately named the Executive.

The body of this unit is made in two parts, both of which are supplied the fabricator in the form of rough castings. The bottom half contains an opening for the insertion of the metal lighter assembly; the top is partially hollowed out to make room for the top of the lighter when the lid is closed. Finishing operations are done by Creative Plastics Corp. and the parts shipped to the manufacturer for assembly. At this time a metal strip is fastened inside the cavity in the base to act as a spring for holding the metal fluid container and lighter mechanism in place. The top is attached to the base by means of a full piano hinge put on with metal rivets.

Intensely practical, the design of the table lighter is such that its broad base lessens the chance of accidental tipping. The bottom is padded with felt so that it cannot mar polished surfaces.

The chief advantage of cast phenolic in this application is that it permits thin cross sections to be used at the top, keeping the unit light enough for easy handling, and at the same time allows the use of much heavier cross sections in the base where the weight is needed.

Attractive yet conservative, this cast phenolic table model lighter is sturdy enough to withstand the rough and tumble on the desk of even the most rushed executive. The unit is furnished in dark and light, plain and mottled color which should blend well with either home or office interiors. They will fit in particularly well with the other new plastic desk accessories such as pen and ink stands, holders for desk and rocker blotters, letter openers, and pen and pencil sets, all of which are on the market and finding their way to better offices and homes.

PRODUCTS*

WAITING in the doctor's reception room? Fretting away the minutes between trains? Stuck for something to talk about on a first date? Pull out a plastic Pocket Action game and the fun begins, whether it's baseball, dice, horse racing or pinballs.

These clever miniature games are the product of Pin-Bo, Inc., with Waterbury Companies, Inc., doing the molding, assembling, packaging and drop-shipments. The housings for the four games are made exactly alike. The difference lies in the color of the case and the markings which are stamped on the transparent cellulose acetate top.

According to what material is available at the time, the body is injection molded of either cellulose acetate or polystyrene in a 4-cavity mold. The metal strip which acts as a spring to propel the tiny metal ball or balls, as the case may be, is next put into position. This spring is of formed steel wire that has been hardened and bent into an "S" at one end so that it will fit into a corresponding "S" groove molded into the left-hand corner of the plastic body. The transparent covers are printed on large sheets of cellulose acetate, die cut to size and glued into place on the molded base.

The pocket novelties are supplied in four colors—red, blue, yellow and green. Directions for playing are on pasteboard glued to the backs.

The games are just the thing to provide diversion for invalids and, although not essentially children's games, they offer a solution to mothers beset with the task of amusing the sick child.

* Reg. U. S. Patent Office.

Plastics Stock Molds*

SHEET ONE HUNDRED THIRTY-SEVEN

Sturdy, durable trays molded of phenolic macerated material are suitable for industrial, hospital or home use. Compacts and smoking accessories can be used for gift and novelty trade. All are available from stock without mold cost. Additional information, manufacturers' names and addresses, may be obtained from the Stock Mold Div., Modern Plastics, 122 E. 42nd St., New York, N. Y. Please state sheet and item number

1627. Heavy duty cafeteria tray, dimensions 14 in. long by 18 in. wide

1628. Round serving tray, overall diameter, 14 inches

1629. Rectangular cocktail tray. Overall dimensions 16 1/2 in. long by 12 1/4 in. wide

1630. Small round serving tray. Overall diameter, 11 inches

1631. Two-piece ash tray with funnel-centered top serving as cover. Diameter 4 3/4 in., 1 3/4 in. deep

1632. Utility box, 5 in. long by 4 in. wide by 1 1/8 in. deep. Holds two decks of cards

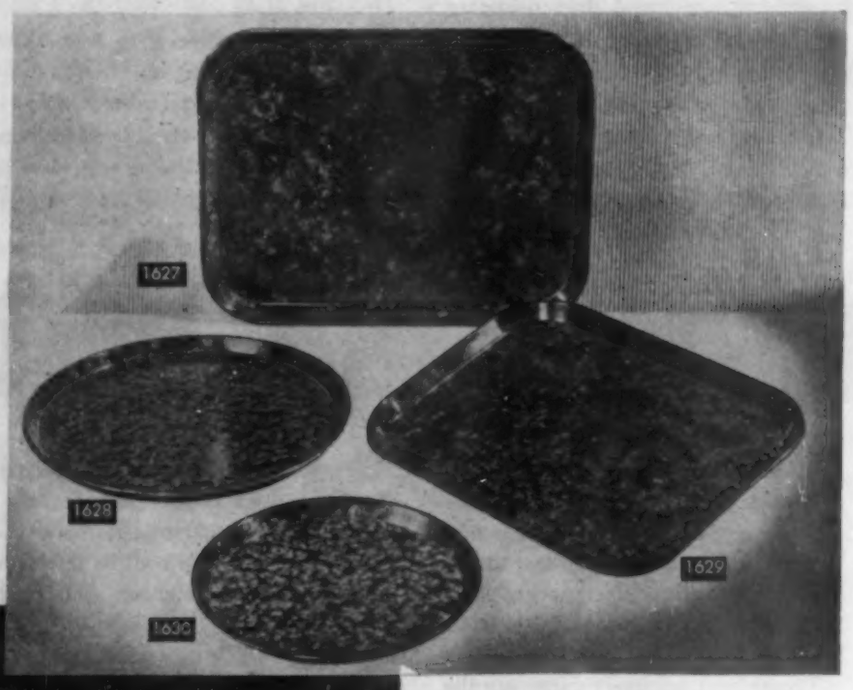
1633. Compact with varied colored center. 4 3/4 in. in diameter. Available in assorted colors with contrasting center

1634. Mock tortoise-shell flap-jack style compact. It features finger-tip clasp opening. 5 in. in diameter, with 3 3/4-in. mirror. Available in solid and mottled colors

1635. Cigarette case with a hinged cover. Holds full pack. 3 in. long by 2 1/4 in. wide by 1 in. deep. Available in assorted translucent shades and also comes in a variety of opaque colors

1636. Shoe horn, approximately 14 in. overall length. Available in clear transparent and colors

1637. Wallet insert, transparent with spiral binding. Available with envelopes and plastic or fiber cover



Items 1–1582, which have appeared previously, are correlated in the Plastics Stock Mold Catalog, available for $5.00

Molders and fabricators are invited to submit samples of stock products to appear on these pages as space permits

* Reg. U. S. Patent Office.

S.P.I. conference and plastics exhibit

NEW materials, new methods, new machines, new products and new ideas for applications of plastics caused thousands of visitors to stand and gape at the first plastics exhibition held in conjunction with the Annual Spring Conference of the Society of the Plastics Industry on April 22 through 27.

Definitely the war is over so far as plastics are concerned; there were no more than half a dozen war uses featured. And just as definitely the industry showed that it has designers and engineers who are able to compete with those of other industries. In general, applications were intensely practical, taking full advantage of the special properties of plastics. Outside of the Flower Show, held at the same Grand Central Palace some weeks ago, the Plastics Exposition probably presented the most colorful set of displays ever viewed by any people anywhere. And, having motion and texture (so to speak), the exhibit of plastics materials possessed greater excitement.

The new laminating materials were shown in boats, fishing rods, skis, caskets, baby walkers, luggage, lighting fixtures and decorative paneling. The vinyls were featured in a huge variety of applications by manufacturers, processors and fabricators, alike. The end uses ranged from transparent hat boxes to saddles and drapery material.

As for polystyrene, there were toy electric trains, a new battery case, tile and radio push buttons, to name but a few. Again melamine dishes attracted attention.

The cellulosics maintained their record for versatility. Some of it was shown being molded on toy presses, some more already made up into playthings. Of particular interest were the white walled sides for tires.

Phenolics and high pressure laminates also were on display in new and different forms. And nylon made its appearance in a variety of forms, molded nylon coming in for considerable attention.

As with other materials, acrylics were shown for the most part in civilian applications. And then there were various new uses for resin impregnated glass fiber and for polyethylene. Companies engaged in plating and metallizing services featured many new uses for their material as did the manufacturers of coating and impregnating resins and adhesives.

A surprisingly large percentage of the plastics machinery manufacturers devoted the bulk of their displays to demonstrations of the operation of their equipment. Not only were there presses of all types in actual operation, but preheaters, high-frequency units, and electronic sewing machines were also hooked up to show the trade and the public just how they worked.

Add the displays of various mold-making and engineering services, of dye producers and of sundry accessory equipment manufacturers and you have a display that caught and held the attention of the general public as well as that of the men of the plastics.

MATERIAL SUPPLY SITUATION

The text of W. S. Landes' speech on the "Material Supply Situation," which was delivered to the membership of the S.P.I. on the first day of the Annual Spring Conference, appears on pages 116A through 116D. Also included are the five charts with which Mr. Landes of P.M.M.A. illustrated the figures included in his talk.

industry itself. There was something to interest every type—whether the person in question was familiar with plastics or not.

Group meetings (April 23)

Button Division

Mr. Broderson advised that OPA may soon eliminate ceiling prices on buttons but warned members against increasing prices. Questions after the meeting indicated that casein would probably remain short for an indefinite period and that future prices for this button material are unpredictable. The survey of the plastics button industry by S.P.I. is not yet ready for tabulation.

Import Market and Button Styling, *Otto Boschen*, Bailey Green & Elger—The button business of the world will in the future be supplied by U. S. manufacturers. It wasn't long ago when Europe was a primary source for buttons, many of them made in the home, but they will never again be serious contenders against U. S. buttons.

The principal reason is price. Take, for example, a button that once imported for as little as 15 cents a gross, despite a duty of 45 percent. A recent shipment of these buttons cost as much as the former retail price of the pieces—a 200 to 300 percent increase. Furthermore, few Europeans produce in volume, so they cannot compete with large scale United States manufacture. In fact it is probable that American buttons may soon find a large market in Europe. We will always buy a few buttons in Europe because of their originality and unusual effects. But if Americans continue to improve quality and perfection of detail, they have little to fear from mass importation.

Compression Molding Division

At this meeting of the compression group, George K. Scribner, Boonton Molding Co., was elected chairman for the coming year.

Relation Between Impact and Flexural Tests for Molded Plastics, *H. M. Quackenbos, Jr.*, Bakelite Corp.—The most important mechanical tests for indicating the strength of our materials are the flexural test and the Izod impact test. But the results are not applied with confidence because their predictions are often reversed by field experience.

The first complete analysis of the Izod test shows that the energy to break the specimen is only a small proportion of the Izod value. The remainder is lost in machine and broken end effects. The isolation of the true specimen energy in the impact test is difficult but a simple alternative is to use the flexural test. The area under the flexural load deflection curve expressed in foot-pounds, is the true impact resistance and has been named flexural work to break.

But flexural work to break is still unsatisfactory in practice and, as explained before, so is the flexural strength. The secret of applying these values successfully lies in appreciating the notch effect. This effect is illustrated by the way in which glass tubing is easily broken after it has been scratched with a file. The same weakening toward flexural and impact loading occurs with molded plastics when they contain notches or their equivalents in the form of holes, corners, screw threads, etc. Moreover, the weakening is greater the sharper the notch; i.e., the smaller its radius. In practice, therefore, such contours should be avoided in the molded object or their effect minimized by making the radius as large as possible.

The notch must be considered in comparing the mechanical properties of molding materials. If the molded object is notched the effective flexural strength is no longer the orthodox flexural strength but that value divided by a factor called the notch sensitivity at the radius of notch contained in the object. The factor allows for the weakening due to the notch.

Impact loading is usually accidental and unpredictable so that we simplify by defining two effective values of true impact resistance or flexural work to break. These are a) flexural work to break (notched) which holds for molded objects containing sharp notches or equivalents, b) flexural work to break (unnotched) which applies to essentially unnotched objects. These two values agree much better with field experience than the Izod value.

Hy-speed Plunger Molding of Phenolics, *C. J. Smith*, Hemco Plastics Div., Bryant Electric Co.—"Hy-Speed plunger molding," was originally brought to the attention of Modern Plastics magazine in February 1945. This article completely covered the methods used.

Since the first announcement of this process was made, Hemco has had over one year of production by this method. They have evolved one very important rule, namely, that there is a definite limit to the number of cavities which may be incorporated into a mold. One example of this factor is illustrated by the production setup for molding fluorescent socket parts. In this case, their production requirements necessitated a 24-cavity mold. However, due to the length of runners, two 12-cavity molds were designed. In order to transfer the material into these molds, which incidentally were mounted in one press, two top cylinders were needed. These units rated at 25 tons for transfer purposes, necessitated a clamping cylinder rated at a minimum of 174 tons. Each top cylinder was equipped with its own reducing valve and they were both activated by a single operating valve.

It is recommended that when molders purchase press equipment for this type of work in the future, they specify a press head containing three bronze bushed holes—the center hole for use for a single plunger operation and the holes on either side for dual plunger operation, due to the number of cavities required for production. A plunger bushing material may well be developed that will have the high strength and electrical characteristics necessary to allow radio frequency dielectric preheating to be incorporated directly in the plunger bushing.

Extrusion Division

New and Proposed Applications in the Extrusion Field, *Morris Sanders*, designer and architect—A very few years ago, extrusion was limited to medium-sized simple sections of rigid cellulose acetate. Then, flexible rod entered the picture, as did acrylic, polystyrene and vinylidene chloride in fine filament forms. The extruders began to learn complementary trades and techniques—the weaving of fine filament and extruded fibers, the machining, bending and forming of rigid stock.

Then came the wartime extrusion developments. Finer filaments, bigger and more complex sections have been mastered as have engineering and manufacturing techniques that go far beyond mere extrusion.

Alert extruders are preparing now for the return to normal, analyzing their best markets, talking things over with their technically advanced friends among the material manufacturers, training a man or two for aggressive product research and sales.

Possible applications (many illustrated by slides) include vinyl or cellulose acetate grilles, extruded plastic webbing for chairs, sheet for upholstering, hardware, flower containers and flower pot supports, louvered lighting fixtures, toys, acrylic or polystyrene cosmetic containers, rebubbled stock for lighting fixtures, a baby bottle of elastomeric compounds.

Cost Factors in the Extrusion Molding Industry, *Nils G. Fischer*, industrial engineer and consultant—Cost accounting deals with the finding of unit costs. Unit costs are the basis for the control of a manufacturing organization in administration, sales and production.

There are two basic systems: first, there is the job or job lot cost system where the manufacturing costs are charged against specific jobs or lots of production. Second, there is the predetermined statistical or standard cost system. In either case, expenses are reduced to a unit cost which is used as a *standard* basis for comparison with all subsequent jobs or periods.

Materials are reported by receiving tickets, material requisitions, scrap reports, spoilage reports, overrun reports, etc.

Labor is reported on the labor time tickets, showing time allocated to job, machine or process.

Overhead is allocated on the basis of the labor time report if overhead is absorbed on the basis of man hours, or on the machine time reports if overhead is absorbed on a machine hour basis.

The first factor in extrusion is material control. The purchasing department sets it up on the books with unit price. With the addition of the labor and overhead cost, administrative charges, gross profit and freight, and quantity discount, a selling price is evolved. An amount is set up as inventory shrinkage and is usually a fixed percentage, determined either by experience or by investigation. Spillage, sawdust at the cut-off saw, and dust lost at the grinder may be considered as legitimate causes of inventory shrinkage. Other items, such as nozzle waste, scrap, overweights when manufacturing to footage on piece orders, burned material, reground material no longer extrudable fall into a different category, being variable.

Overhead comprises all costs of manufacture other than direct material and direct labor, and it is a factor in inventory value. It must be prorated among job orders or standards on some arbitrary basis such as rate per direct labor hour, percent of direct labor cost or rate per machine hour. If overhead rate is based on a low level of output, then it will be too high and the factory cost will be so great that competition cannot be met. Other important considerations are scrap, shipping department costs, standard tolerances and the cost of special dies.

Annual business meeting

TECHNICAL COMMITTEE—*N. J. Rakas* reported that the S.P.I. Technical Handbook should be ready for distribution by November. He stated that some advance chapters are being released and are receiving widespread interest. Chapter 4 on Testing Plastics Parts is just out.

EDUCATIONAL COMMITTEE—*Horton Spilzer* stated that "Plastics, the Story of an Industry" has received distribution in all colleges, in libraries, newspapers, 675 major radio stations, Army and Navy separation centers and vocational depots. The committee checks the plans of various states for school plastic courses and checks plastics advertising for truthfulness. N. Y. University's School of Retailing is getting S.P.I. cooperation in its 14-week course on merchandising next Fall.

ACCOUNTING COMMITTEE—*R. S. Oliver* reported that the executive accounting or central committee, with 20 active members, has an advisory panel of 50 company representatives and a subcommittee of 7 which has just completed the writing of the Uniform Accounting Manual, now printed but not bound. The subcommittee will continue to work on special procedures in plastics costing.

PUBLIC RELATIONS COMMITTEE—*John Sasso* reported that the membership information brochure for potential members is very popular, that S.P.I. advises the Army and Navy on plastics matters, that membership is maintained in the Boston Conference on Distribution, that S.P.I. keeps a complete list of plastics courses in colleges and universities, that help is being given in the placement of returned servicemen, that trade association contacts are regular, including the N.R.D.G.A. In direct publicity, 196 trade publications as well as daily newspapers and press associations receive releases. Direct help is given editors in preparing special features and issues.

FEDERAL COMMUNICATIONS COMMITTEE—*Wm. T. Cruse*, executive vice-president, reported that the Federal Communications Committee has a presentation before the F.C.C. on the matter of frequencies for electronic heating and on shielding specifications. He also presented the financial report which has been mailed out to members. The amendment to the by-laws was adopted by the meeting.

Material supply

Following his speech on "The material supply situation," which is presented in full on pages 116A through 116D, W. Stuart Landes, president of P.M.M.A., answered a number of questions from the floor. Some of the more interesting were:

Q. Are you delivering molding powder to customers other than molders?
A. No. Other raw materials producers in the room answered similarly.
Q. How much material is being exported?
A. About the same percentage as prewar with most of it going to Canada.
Q. Are you aware of a black market in plastics?
A. We know no black market operators.
Q. Are you working full time?
A. The chemical industry is a 7-day around-the-clock operating industry.
Q. Are you selling to newcomers?
A. Only in a very few examples when they are veterans or small businesses with a CC rating and then only in very small quantities.

S.P.I. OFFICERS FOR 1946–47

The results of the annual elections of the S.P.I. were as follows: director and chairman of the board, George K. Scribner, Boonton Molding Co.; director and president, Neil O. Broderson, Rochester Button Co.; director and vice-president, George H. Clark, Formica Insulation Co.; director and secretary-treasurer, Warren E. Hill, Prolon Plastics Div., Pro-phy-lac-tic Brush Co.

Directors are: E. L. Anderson, Globe Tool and Molded Products Co.; Norman Anderson, General Molded Products, Inc.; John D. Benedito, Canadian Resins and Chemicals Ltd.; Gordon Brown, Bakelite Corp.; Robert A. Cooper, Plastics Die and Tool Corp.; Charles F. Elmes, Elmes Engineering Works; Donald L. Gibb, Dow Chemical Co.; Herman B. Lermer, Celluplastic Corp.; W. H. Milton, Jr., Plastics Div., General Electric Co.; N. J. Rakas, Chrysler Corp.; Paul C. Tietz, Richardson Co.

Group meetings (April 24)

INJECTION MOLDERS

Horace Gooch, Worcester Moulded Plastics Co., was elected permanent chairman of the newly organized Injection Molders' Division of S.P.I. at the close of this meeting, following the two speakers—Morris Yellin and Bert E. Cash.

POTENTIAL HAZARDS IN CUSTOMERS' AND MOLDERS' RELATIONS, *Morris Yellin, Sr.*, Superior Plastic Co.—The plastics industry has now reached a period when shortcomings will no longer be overlooked and when suits for damages may be expected for late delivery, damaged goods and similar mistakes in operation. Slight errors in processing can result in the delivery of faulty goods without the processor being aware of his culpability. Or broken molds can delay delivery. There are many things that can happen in a molding or processing plant and that can result in financial losses to the customer or distributor, causing him, in turn, to seek financial adjustment from the molder.

This sort of thing only has to happen once to seriously damage a molder. Fabricators of metals, for example, are familiar with the characteristics of these materials and have no such troubles to overcome as do plastics operators whose industry is still in the development stages. Ours is an industry in which new materials come out constantly. Thus we are continually exposed to busi-

ness hazards which have been eliminated from industries that work with materials known for centuries.

We must see to it that our sales contracts are so drawn that we are adequately protected. If a job is complicated, if it is to be made out of material with which we have had but little experience, if the contract involves a sizable amount, we should consult our lawyers.

Only time and experience which comes from extensive experimentation and much practical usage will enable us to become familiar with our materials. The plastics molder is subject to many of these hazards. He requests of those with whom he deals only that his obligations and liabilities in any given case may not exceed his prospective gain. This is but fair business practice.

FIELD PERFORMANCE OF FORTICEL, *Burton E. Cash*, Chief, Product Development Div., Celanese Corp.—During the course of the field molding of Forticel, careful records of its moldability and machining qualities were kept. Further, molded parts were brought back to the laboratory for comprehensive testing of their strength and dimensional stability. Some of these parts were toothbrush handles, combs, optical frames, safety goggles, industrial housings, flashlights, saw handles, large screw driver handles and fountain pens.

Although cellulose propionate parts molded in the laboratory showed surfaces with a high finish, it was not until extensive field molding had been done that this was recognized to be an important property of the material. Unlike other cellulosic plastics, this high surface luster was maintained over widely varying injection cylinder temperatures and machine cycles.

Another advantage discovered in the field molding which was not evident in small scale laboratory molding was the shorter machine cycles possible with this material. For example, a two-cavity flashlight die currently being operated on a 37-sec. overall cycle was successfully run in Forticel on a cycle of 27 seconds. Cycle reduction cannot, however, be realized on every injection mold. Inserts that are removed manually in many cases govern the minimum cycle. In other cases the cycle is limited by the rate at which the particular machine and heating cylinder can properly plastify the molding material. Still other jobs of very heavy cross-section or with heavy ribbing must be held under high pressure until cooled or hardened to a certain point. In no case did the cellulose propionate require a longer cycle than the standard materials being used, and in most cases substantial decrease in molding cycle was achieved.

A point of importance to a molder relates to the compatibility of cellulose propionate with other molding materials. This material can be mixed in all proportions with the cellulose acetate butyrate commercially available today, but cannot be mixed with any other molding material. This means that it can follow cellulose acetate butyrate through the heating cylinder of the injection molding machine without any costly cleanouts. These facts are important also because they govern the separation and classification of scrap and indicate the care which must be exercised in the dryers.

The machining and finishing of parts injection molded of cellulose propionate present no particular problems. If certain items need to be ashed and polished, the techniques used for cellulose acetate apply. Dies can be designed with smaller gates than are generally found necessary for cellulose acetate. This feature, added to the lack of skin formation on the moldings, permits easy separation of the parts from the sprues and runners. Parts molded of Forticel can be cemented as readily as parts of cellulose acetate, but some changes in the chemical constituents of the cements are necessary. The material is expected to be in quantity production in the first half of 1947.

MACHINERY DIVISION

THE CASE FOR DECONTROL OF MACHINERY AND EQUIPMENT IN THE PLASTICS INDUSTRY, *Donald H. Reynolds*, Machinery & Allied Products Institute—The experts who assume that our industrial plant can overnight smother the economy with low cost goods are in error. There is a deficiency of machinery to do this job, and that deficiency results from the depression of the thirties as well as from four years of war. Not only must we get volume production; we must cut costs. And the only way to do it is use the most modern machinery we can.

Increases in material and wage costs have not stopped and can only be discounted by an increase in productivity per worker. But production of machinery today at 1941–42 prices is impossible. It amounts to a paralysis of incentives. Rising costs have taken profits lower and lower until machinery makers are losing money. The current wave of wage increases is making the situation worse. Machinery is sold for delivery months ahead and orders taken on the basis of past prices and costs are sure to cause insolvency when costs are bound to rise in that period. Under the new OPA wage-price policy, subcontractors are upping wages and applying for price relief—so the prime contractor is bound to lose money unless he, too, can get price relief.

The OPA system of price relief is geared to consumer goods production. The OPA likes to administer relief on an *industry* basis, but even Mr. Bowles admits that you can't define an industry in the machinery field because operators differ so widely in their operations.

Cost of living is affected by consumer goods prices but not by capital goods prices, but the use of more efficient capital goods will lower consumer goods costs. There need be no fear of too little competition in machinery manufacture, because in addition to the severe competition to produce better machines at lower cost there is the government-owned surplus equipment on the market.

The Machinery Institute has recommended that industrial machinery and equipment be exempted from the proposed price control extension legislation. MAPI reports that OPA plans decontrol of most industrial machinery, but this will not happen at once, since it will be handled by a series of amendments to Supplementary Order 129, each suspending price controls over additional items.

As a result of group discussion following Mr. Reynolds' speech, it was decided that a committee be formed, headed by C. S. Davis, Jr., Lake Erie Engineering Corp., the committee to be made up of approximately three men from each type of machinery company. This committee is to discuss ways and means to present to OPA the case for decontrol of plastics machinery and equipment.

FABRICATING DIVISION

THE RETAILER'S AND CONSUMER'S NEED FOR KNOWLEDGE OF PLASTICS, *Dr. Charles M. Edwards, Jr.*, Dean, School of Retailing, New York University—Clearer, more concise, better organized information is the greatest need in the plastics industry today so far as the average retailer and layman are concerned. It would seem that there are four steps which the industry can take to win for itself and its products the full measure of acceptance and adoption they both deserve. These might be called 1) simplification, 2) improvement, 3) information and 4) combination.

Simplification—This means simplification both in products and in names. The 30 basic plastics materials and all their differing formulations are sometimes more confusing than helpful to the merchandising executives of retail stores. And adding to the confusion is a multiplicity of trade names and tongue-twisting generic terms. Neither the retailers nor their customers have any intention of attending schools of technology to learn the plastics vocabulary. So it would behoove the plastics industry to consider seriously the matter of simplification.

In this connection, one should not forget the instinctive tendency of humans to distrust and to discredit the things they do not comprehend. Unfamiliarity with a product or lack of understanding of a product inclines a portion of the public toward brushing them aside as no good, if for no other reason than to cover its own ignorance.

Application—As for application, every effort must be made to develop more useful products and to guard against inferior products. The industry must avoid the production of merchandise that is unattractive due to such shortcomings as bubbles, discolorations and irregularities, and at the same time guard the

The John Wesley Hyatt Award

Two men, Paul D. Zottu and Virgil E. Meharg, shared the John Wesley Hyatt Award for outstanding work in the development of electronic heating of thermosetting plastic materials. It is the first time the award presentation has been divided, half of the $1000 going to each gold medalist.

VIRGIL E. MEHARG

PAUL D. ZOTTU

Mr. Zottu, consulting electronics engineer, and Mr. Meharg, superintendent of development, Bakelite Corp., were selected for research on electronic or high-frequency heating which they carried on separately and simultaneously.

Both men found that plastic materials could be heated by the electronic process by placing them between two metal plates. Electric waves of high frequency—similar to waves used in short wave radio broadcasting, which are short and change direction frequently—pass between the plates and through whatever material is placed between the plates. Inside the plastic, molecules pulled back and forth by the electric waves create a friction and develop heat. The internal friction heat raises temperatures more rapidly than heating applied externally.

Molds, lighter in weight and less expensive, can be used with the high-frequency process since less pressure is needed in molding electronically preheated materials.

Mr. Meharg, a graduate of Rice Institute, studied at the Univ. of Minnesota and Northwestern Univ. and joined Bakelite Corp. 22 years ago.

Mr. Zottu studied at Wesleyan University. He was associated with the Radio Corp. of America as a chemist for 6 years, then joined the Thermal Engineering Corp. Since June 1945 he has been a consultant on high-frequency heating.

The Hyatt award, sponsored by Hercules Powder Co., was presented at ceremonies following a banquet attended by members and guests of the S.P.I. at the Hotel Commodore, New York City.

customer from dangerous merchandise. Finally, both material suppliers and processors should shun the use of materials in applications for which they are unsuited. A program for the pretesting of various materials under conditions that resemble actual use might be of great and lasting benefit.

Information—One of the best ways of informing the retailer, and the public, regarding plastics products is through informative labels carrying the following facts: 1) name of product, 2) material of which the product is made, 3) uses for which product is intended, 4) special benefits the product offers, and 5) the proper care of the product. Not only do labels of this type act as a ready reference for salespeople but they serve as buying guides to customers who are "just looking," without aid of clerks.

Combination—It is common knowledge that no firm alone determines the success or failure of its business. Your success depends almost as much upon your competitor's efforts as upon your own. The customer who has had an unhappy experience with one plastic product is likely to jump to the conclusion that all plastic products are faulty. It is, therefore, to the interest of every member of the plastics industry to build an ever more powerful association for ever better cooperative effort.

Low-pressure Molders

The Competitive Position of Structural Plastics Materials, *Frederick Z. Pearson*, Plastics Div., Lyon Metal Products, Inc.—In times like these, it seems almost out of place to discuss the competitive standing of any material or any product at all. Yet we should be very much concerned with future trends. Our ability to produce is ahead of our talents for distribution.

In spite of competition with steel at 3 cents per pound, I feel that ultimately we can successfully face the competition from different metals in sheet form or otherwise; and from the various wood base products. Whether we can or not depends on how intelligently and how courageously we face a number of facts.

Most present methods of low-pressure laminated molding and most resins now in use will not be able to justify themselves economically, except where the production volume is below 3000 units, or where unusually large parts or frequent design changes are involved. That is a harsh statement to make before this group, but all of us are interested in seeing our phase of the industry grow and constructive criticism should be welcome.

Plastics excel as electrical insulation, in chemical resistance, thermal insulation, and offer unusual decorative characteristics. In the majority of structural applications, however, these characteristics will enter only as additional sales points, and competition must be met on such common points as appearance, strength, design possibilities and cost. With proper design, full advantage can be taken of the strong points in each material, and its weaknesses counteracted.

Raw material costs are easily the one most important factor in the structural plastics outlook. In most of the products to which structural plastics can be applied, the raw material, based on current prices, readily represents between 50 and 75 percent of total cost. That places us squarely in the middle of some very strong opposition from lower cost steel, aluminum, hardboard or plywood products. On the basis of a thorough investigation of a considerable number of actual and possible large area structures, it may be stated that by setting aside 16 cents per pound of finished product, an array of raw materials can be found, that leaves very little to be desired in appearance, permanence and performance. Our resins presently range in costs from 14 cents a pound

all the way to $6.05 a pound. Of course, costs per cubic inch are the real criterion and not cost per pound.

With regard to fillers, the same picture applies, although fortunately, our costs here range from 2 cents to only $1.50 per pound. Fillers constitute 50 percent or more of most structural moldings. Therefore, their lower cost obviously is most helpful. But here again we sometimes question the use of high priced fillers for high performance per sq. in. when the ultimate customer does not buy performance by the square inch. He buys performance per dollar!

The manufacturing conversion factor is made up of a great many complicated influences, which are also part and parcel of our problem. Sales volume, or rate of production, is the crucial factor. All highly competitive industries have found that the only alternative to ever diminishing profit margins is volume, volume and more volume. This serves only to remind us that ours, the Plastics Industry, is a mass production industry.

The structural plastics industry needs better methods. It is true that present methods allow us to get by with often temporary and primitive and, therefore, low-cost tooling and production methods. The resultant product, however, as far as my studies went, has poor dimensional stability and poor finish on one or both sides which makes after-finishing unusually expensive. Also the labor costs are higher. Better methods, even though involving high initial tool and equipment costs, justify themselves in lower unit costs, lower upkeep, and uniformity of quality.

APPLICATIONS OF LOW-DENSITY CORE MATERIALS, *R. A. Hoffer*, Technical Service Department, E. I. du Pont de Nemours & Co., Inc.—Sizable fields for application of low-density cores are seen when techniques of fabrication have been fully worked out and production-line methods established. We examine these materials from the standpoints of their function, general properties, types and scope of application.

The function of the low-density core in sandwich lamination is comparable to that of the lattice bars or struts in a girder, i.e., to hold the top and bottom members firmly and thus increase the stiffness of the structure without correspondingly adding significantly to the weight. The thickness of the laminate contributes rigidity and stability under stress. The core material so supports the faces that when the laminate is subjected to columnar loading, as in a wing structure, a substantial portion of the compressive strength of the thin face material can be developed. By the use of the core materials, structural efficiency and simplicity in design may be had, saving in manufacturing cost.

Core material must generally meet these requirements: it must be sufficiently strong in tension applied in a perpendicular direction to the surface to prevent buckling of the faces through tensional failure in the core itself; the compressive strength of the material must be sufficient to resist local loads due to rough handling; it must possess a certain degree of toughness which will permit the development of strength in the faces; it must have rigidity in itself to hold the sandwich combination stable while the faces develop their strength; it must have certain shear strength in order to perform its function adequately; it must not be brittle or granular in structure.

Other properties, important for specific uses, may include: resistance to heat, thermal conductivity, acoustical properties, flammability, water absorption, chemical resistance.

Types of core materials: 1) foamed thermosetting; 2) foamed thermoplastic; 3) foamed rubbers; 4) gridded cores, honeycomb with glass, fabric or paper grids and resin binders; 5) natural, i.e., balsa; 6) foamed glass; 7) foamed calcium alginate.

Applications for the low-density core materials have increased greatly in the first few months following the war, many in aircraft parts. Decks, hulls, roof sections, wall panels, cabinets and furniture may be cited as contemplated applications in boats. The insulating properties of these core materials, plus the structural advantages gained by their use, justify their consideration in housing. Luggage applications would take advantage of the low weight and structural qualities which can be obtained by these products. Refrigerator and toy industries offer a large market.

TOOLING AND PRODUCTION METHODS FOR LOW-PRESSURE REINFORCED PLASTICS, *John J. Townsend*, engineer and consultant—Five techniques for the production of large molded or formed structures in reinforced plastics show possibilities here.

1. *Molded plywood*, not an ideal medium for low-pressure work, was used in complex shape in the evacuation leg splint. Specifications called for a splint that could be transported easily and would permit good traction to a leg fracture, without failure. It had to keep the injured member afloat in the event the wounded individual was forced overboard. Stress requirement for weight was high. Supported only on the butt end, the traction end had to take a pull force of 150 pounds.

It was preferable to use a production method yielding the highest possible number of pieces with a minimum of labor, so this technique was developed.

Aircraft grade birch veneers were worked out into a cross-banded lay-up to give higbest strength values in the directions required. Veneer blanks were dimensioned in such a manner as to permit lay-up into a single, easily handled, flat unit assembly that could be formed into the shaped splint at a single stroke of a die. A melamine reinforced urea was selected.

Veneers were first trimmed and spliced into the most economical sized blanks. They were then clamped in multiples between templates, first to be band-sawn to primary shape, then the more difficult cuts made with pneumatic routers. Each ply of veneers embodied a different set of dimensions. Pressure was applied by means of fixed, heated Kirksite dies in a hydraulic press. Pressure, not exceeding 400 p.s.i. over the projected area of the piece was exerted and a die temperature of about 300° F. was held.

2. *Formed wood laminates* have applications that really fit into two broad classifications. One involves complex shapes; the other only simple shapes. Complex shapes are usually more economically done in reinforced plastics materials other than wood. Simple shapes, however, promise the possibility of a considerable number of commercial applications.

Manufacturing can be done by the rubber bag method over a wooden or metal form in an autoclave, between dies in a hydraulic press, by clamping between shaped cauls with hand clamps or in a special purpose clamping jig. In these methods heat-setting plywood adhesives of urea or phenolics would be used. In the case of the hand-clamped assemblies, resorcin or the new non-crazing crack-filling urea would be in order.

Capacity can be multiplied rapidly to meet demand. As demand falls off on any item, any part of such equipment can be demounted for use elsewhere or the entire jig can be taken down.

3. *Post-formed fabric laminates.* The procedure for post-forming is simple enough—blanking, piercing (if required) heating and forming.

A wide choice of preheating methods exists for post-forming. Relatively high temperatures are usually employed for phenolic post-forming. The forming presses can be simple structural steel frames in which are mounted single pneumatic cylinders. Dies may be machined from soft steel on a shaper, or may be wood. The pneumatic cylinders of the conventional double-acting type, with compressed air fed into them by means of solenoid controlled 4-way valves, have been used. Closing and opening speeds are controlled by set-screw throttling valves to prevent impact at the end of each stroke and to provide safe operating conditions. Time relays, in conjunction with magnetic contractors, time the cycle of these presses. One operator can handle a battery of two presses, each press complete with its own bank of heat lamps. Provision is made for final cooling outside of the dies, so the entire cycle is timed around fast heating.

4. *Fluid pressure molded laminates* mean the use of unidirectional fluid pressure. A case in point is a football helmet molded of phenolic impregnated canvas laminations. Die cut, uncured phenolic impregnated canvas is assembled over a shaped helmet block or form and sewed together. Hat press equipment is used as production machinery. The mold is cast aluminum of ribbed construction and heat is conducted from the walls of the receiver to the surface of the mold.

The molding operation consists of fitting a previously made-up

preform into the mold, closing the press, and applying the direct hydraulic pressure head. A parting film is generally used to prevent the plastics binder in the fabric from sticking to the rubber. A stroke on the pump applies the pressure, in this instance 200 p.s.i., perpendicularly and equally in all directions. Mold temperature is maintained in the vicinity of 300° F., and the cycle is held for about 6 minutes.

Widest application of this technique is found in work having little or no draft and where undercuts are present. It is limited to products where only one good mold-finished surface is essential. Any type of flexible reinforced plastics material can be used within the pressure limits, up to as high as 500 p.s.i.

Matted fiber reinforced plastics were used in a phenolic baby stroller. For an item such as this, sisal reinforced phenolics probably have more to their credit than any other material.

A preform is first made from a heated blank of the fibrous plastic. With the exception of a hold-down ring providing controlled slippage, standard drawing methods are used in producing this preform. After a cooling period has elapsed, the draw plunger is raised and a completed preform is removed ready for molding. Final molding operation is accomplished in a standard hydraulic press equipped with long strain rods to accommodate the deep draft dies which are constructed of cast Meehanite which has been machined, polished and chrome plated. Temperatures in the neighborhood of 300° F. and a pressure of 700 p.s.i. complete a cycle in approximately 8 minutes.

Afternoon session (April 24)

Practical Method of Heat-Sealing Thermoplastics with High-Frequency Energy, *Wiley Wenger*, Radio Corporation of America—The postwar promise of sealing plastic fabrics electronically in the manufacture of civilian goods is now being realized. Industry is now using electronic power in the fabrication of dress shields, bathing caps, raincoats, shower curtains and many other thermoplastic products.

A major advantage of this technique is that the high-frequency electrical energy employed is not converted into heat until after it enters the work material. The metal electrodes used to apply the energy remain cool while heat is generated in the material itself and is conducted away from the outer surfaces of the material by the cool electrodes. This results in a quick concentration of heat at the interface of two pieces of material, permitting degree and interval of heating to be closely controlled.

Since the electrodes themselves are used to apply pressure, the three essentials of heat sealing are 1) uniform heating of the surfaces to be joined, 2) uniform pressure and 3) uniform cooling. These can all be accomplished simultaneously and in a single operation without excessive heating of outer surfaces of material.

Several R.C.A. electronic power generators and special applicator equipment were displayed and demonstrated at the exposition. These include a bar sealer capable of producing a seam 48 in. long in one operation and "electronic sewing machines." The long electrode bar sealer can be used either to produce a single long seam at one shot for large articles such as raincoats or shower curtains, or can be used to seal several smaller objects such as tobacco pouches, at a single shot.

The Singer machine seals materials by means of a small bar sealer in which the upper electrode rides up and down rapidly, each pressure stroke overlapping the previous one, as the material is fed through the aperture by intermittently driven feed wheels. The Union Special machine employs roller electrodes which apply power and feed material through the machine at the same time, thereby making a continuous seam of any length or contour.

Massachusetts Institute of Technology Plastic Research Project of P.M.M.A., *F. H. Carman*, general manager, P.M.M.A.—The P.M.M.A. in sponsoring fundamental research may be taking a new step for the Plastics Industry, but it is not new for industry in general. Specifically, it is believed to be the only type of cooperative undertaking that would be proper for the Association to sponsor. It must be understood that this particular type of research is not supplanting any other research now being undertaken on plastics or the work of the individual research laboratories of the P.M.M.A. members. The American Society for Testing Materials has many times recognized the need for research on methods of determining fundamental properties of plastics, and it was only after extended consultation with that organization that the present program was established.

A P.M.M.A. survey disclosed that generally speaking the optical and electrical properties of various plastics were well known and the methods of evaluating them were generally satisfactory. However, it was evident that mechanical properties were in most need of study and research. In subsequent meetings with the technical representatives of the Industry (let us emphasize that representatives of S.P.I. and the consuming industries were called in) it was agreed that the most good could be obtained from a study of mechanical properties of plastics aimed at a more fundamental understanding of the physical mechanical nature of plastic materials, the development of methods of testing to permit determination of these fundamental properties, and the development of ways of using fundamental properties of this type in the design of plastic structures or use of plastics. It is hoped that this research project will develop new methods of testing plastics and permit more accuracy in predicting behavior under conditions of use and make it possible to use data in designing plastic parts, thus eliminating much of the empiricism now used.

The program will include consideration of the effect of molding method on the mechanical properties of plastic parts; how the rate at which loads are applied affects the strength properties and ductility of these materials; how they may be expected to act when loads are applied over long periods of time; what may happen when loads are repeatedly applied and removed as in structures subjected to vibration; what the effect of different temperatures may be upon plastics of various types; and what may be the effect of age upon the strength properties. These studies will include development of new test procedures and/or equipment to the extent which the research indicates practicable.

It is the further aim of this research work to correlate mechanical properties with chemical structures of the plastics. Another by-product which can be anticipated from any research on plastics in an educational institution is the training of personnel for the Industry. The work can be carried on under Fellowships and by graduate theses stemming from purposes of the research.

As the work at the Massachusetts Institute of Technology progresses, it is planned to make the results freely available for publication in technical journals and other suitable publications as promptly as possible. Any inventions, etc., which may arise from the research work will be administered for the ultimate benefit of the Plastics Industry, subject to such arrangements that M.I.T. may deem proper.

It is the objective that fundamental properties of all the major types of plastics be investigated. Early in the program it became obvious that all materials could not be studied at the start of this work; it was subsequently decided that it would be more apropos to initiate these studies on a simple and relatively uniform chemical compound—without so-called "cross linkages," filler or plasticizer. Methyl methacrylate in sheet form was therefore selected for the initial experimental work.

Plastics Picture in South America, *C. C. Concannon*, Chief, Chemicals and Drugs Div., Bureau of Foreign and Domestic Commerce—Dollar volume output of plastics rose 325 percent between 1939 and 1944, now standing in the latter year at about 332 million dollars. Expansion plans for this year and next will increase this further. Exports increased from 2½ million dollars in 1937, to about 17 in 1944, 70 percent being cellulose plastics.

In 1944 about 12 percent of our plastic exports went to Latin America. This can be increased if a more liberal credit policy is supported with careful selection of sales outlets and agents. The manufacturer's agent on the spot is the key man, and he will quickly absorb technical information.

Latin American can use much bonded plywood and other laminations, particularly in the building field. More than half

of the countries neither manufacture plastic materials nor produce semi-finished forms of plastics. Unfortunately, complete statistics covering exports and imports of plastic materials to these countries are not yet available. Argentina almost tripled her urea resins import during the war years. She is the largest producer of plastic products in Latin America, and is therefore a market for plastic materials and for semi-finished plastics. Applications in Argentina have been more or less novelties.

Brazil imported 92,000 dollars worth of U. S. plastic materials and production in 1944 represented an increase of 330 percent from 1941, half of total Latin American imports being from this country. Formerly German polystyrene was widely used, but cellulose acetate is replacing it to some extent. Plastic processing plants are not modern and articles produced are generally small.

Chile imported 221,000 dollars worth in 1944; she is quite a big producer of plastics. Her minimum annual consumption requirement is established at around a million pounds. Eight hundred workers are producing quite a wide variety of products, many on hand-operated presses.

Colombia has only one manufacturer of plastic materials, and that firm makes phenolic powder for use in its own molding plant. There are 8 molders in the country and recent orders have been placed for additional equipment.

Mexico is a big importer of cellulosic plastic materials and alkyd resins from the United States. Because of lack of materials, production of finished plastic products has declined in Mexico since 1941, but plans for expansion in the molding industry are tremendous. At present there are 41 injection and molding presses in the country and this will probably be tripled.

Peru produces no plastic materials and very few finished plastic products, those she is making being compression molded only. The market potentiality for more plastic articles is limited.

Uruguay is likewise backward in its use of plastics, but is expected to use much more in household articles, novelties and fancy items, as well as in industrial plastics.

Venezuela manufactures no plastic materials and uses but small amounts of cellulose nitrate, acetate and casein materials. However, she imported almost 8 times as much plastics in 1944 as in 1941.

Cuba produces no plastic materials but does quite a bit of molding and fabricating, chiefly in the smaller product range, such as buttons, combs and accessories.

The effect of U. S. influence on the Latin American standard of living will definitely increase possibilities in the export market.

LOW-PRESSURE MOLDING, *John E. Stokes*, Bakelite Corp.—New low-pressure resins are: plasticized resins for punching stock, shock-resistant resins for industrial gears, chemical-resistant resins, fast-curing resins, high dielectric resins and light-colored varnishes for decorative applications.

Low-pressure resins must have high flow and must be curable at low pressures while maintaining electrical and mechanical qualities as good as those of high-pressure laminating resins. But while the trade names of high-pressure laminates are well known to the public, those of the low-pressure manufacturers are known only to a few people who were engaged in war production. A big job of education and advertising has to be done. Boats and caskets are the first postwar products in this field.

Two types of thermosetting resins are generally used: phenol-formaldehyde and the ester-type resin. Qualities of the lamination depend on the filler, the resin and the method. Various low-density core materials are available and of these the honeycomb is of interest where low weight is a factor. Cotton cloth, paper and glass cloth are all used in honeycomb fillers, but 90 percent of current production uses an 80-square weave cotton cloth impregnated with a phenolic varnish. When paper is used, phenolic varnish is the resin, but when using glass, polyester resin is needed.

Deep-drawn laminates (see MODERN PLASTICS magazine, March 1946) are being made by Andover Kent Aviation Corp. Their ice bucket involves a new principle in low-pressure molding. A laminated dust pan, a bathroom scale and many luggage items are also made.

Post-forming is used to shape objects from flat sheet laminates. The sheets are usually obtained from a high-pressure laminator, are cut to size, preheated at a temperature below 500° F., put over a male or female die, pressed by air or by toggle pressure, and cooled to shape in the press. Portable refrigerators, blades for fans and many other things are now made this way.

There are over 100 different resins available for low-pressure molding, numerous types of molds and several different processes.

Plastic film, sheet and fabric division

THE NECESSITY OF SOUND TEST METHODS AND THEIR CORRELATION TO END-USE, *Charles W. Dorn*, Research Laboratory, J. C. Penny Co., Inc.—The necessity for quick action to devise standard test methods for supported and unsupported, coated, cast and calendered film cannot be emphasized too strongly, according to all speakers at this meeting. A bill forbidding distribution of certain materials is about to be introduced in Congress. This would be harmful to the plastics film industry unless quick action is taken to provide reliable tests in regard to flammability and other characteristics.

More than 30,000 tests have been made relating to fast color under all types of washing conditions but it has not yet been possible to correlate the results. Rainwear and shrinkage tests are in a similar state although U. S. Army experience has resulted in a fair amount of information on this subject.

The necessity for determining the stability of film to avoid tackiness; brittleness after contact with oils and greases or after washing with soap; tendency to stain other garments; color fastness; effect of aging; skin irritation and to determine the degree of flammability were pointed out.

The inability of present testing methods to show color fastness for plastic film was used as an example. Sun lamps will not deliver the same intensity of light over such long periods as from 200 to 500 hr. and there is no place in the test to determine the amount of exposure which a given article will withstand. In the textile industry there is a classification of articles according to the exact number of hours a fabric will withstand light exposure and they are rated accordingly with Class I, the lowest at 10 hr., being recommended only for low exposure and use; Class II moderate; Class III, at 40 hr., satisfactory for clothing; Class IV, 80 hr., superior color fastness suitable for awnings, beachwear, etc.

Flammability tests are more necessary than any, as legislation is being considered in various states as well as nationally and some laws may be patterned after the California edict of a few years ago which declared that anything more flammable than cotton in its natural state could not be sold. The joker of course is that no one could tell just what that meant.

Mark Bortman of Bortman Plastics pointed out the great future in store for vinyl films which are now in much the same position as rayon at the end of World War I. He advised the necessity for establishing standards quickly. Plastics have already become a permanent part of the luggage, handbag and similar industries, as a supplement to leather.

Convention social events

A Pioneers luncheon was held on April 22, the day preceding the official opening of the convention.

Luncheon on April 23 was under the chairmanship of George K. Scribner. At the head table were officers of various organizations in the plastics industry. Dr. W. J. Worboys, vice-chairman, British Plastics Federation, brought greetings from that body. Major General Leslie R. Groves, Officer-in-Charge, Manhattan Project, gave an address on development of the Atomic Bomb.

Dinner on April 24, at which the Hyatt Award was announced, was presided over by Neil O. Broderson, president of S.P.I. The toastmaster was Dean Richard F. Bach, and the Hyatt Award was presented by E. R. Weidlein, director, Mellon Institute of Industrial Research. The address of the evening was by Dr. Preston Bradley, People's Church, followed by a concert by Fred Waring and his Pennsylvanians.

Plastic materials supply situation*

by W. STUART LANDES†

The facts on the raw materials situation as presented by W. Stuart Landes, president of P.M.M.A., are of utmost importance to the plastics industry and to consumers who are in the market for plastics materials. MODERN PLASTICS is happy to present his conclusions and proud to have been able to provide the latest figures on machinery distribution, which were assembled by the staff with the aid and cooperation of machinery manufacturers.

THE material producers are keenly aware of the seriousness of the raw material situation. They are doing everything in their power to bring about effective remedies. In order to get at the problem intelligently an analysis of the present situation and a review of the factors that have brought us to this point are desirable.

The demand for most of our products exceeds the supply by an average of 3 to 1. This condition has become progressively worse since V-J Day. No one is happy about it. The material producers individually realize their responsibility and are, I am convinced, using their best judgment in the decisions that have to be made. It may surprise you to know that the total output of plastics today is running almost 2 to 1 compared to 1941 and that shipments of all types of molding material are running 5 to 3 compared with 1941.

Underlying causes of plastics shortage

Let us look into the factors that have been responsible for the shortage. 1) There is a world shortage of civilian goods caused by years of war and an accumulated pent-up demand for those goods. 2) Most of the former industrial centers of the world except the United States, are dried up. 3) In the United States, at least, consumer demand has been further stimulated by high wages and accumulated savings.

In the plastics industry there are further influences at work. People have been made so aware of plastics that they are turning more to these materials, not only because of merit but to relieve shortages of other materials.

The natural question is, "How did the molding and fabricating capacity get so far out of balance with the material supply?" Let us assume that these two factors were in equilibrium in 1941. During the war this capacity was greatly increased and today is being enlarged at an even greater rate. Material producers, on the other hand, were largely denied the privilege of expanding plant capacity during the war. Some of the newer plastics were expanded but, generally speaking, the rule was that as long as a manufacturer's capacity was sufficient to take care of the demand for war purposes, no priorities for expansion would be granted. Since V-J Day, basic increases in plant capacity have not been realized. The increased output today has been brought about largely through the ingenuity of the chemical industry in finding shortcuts and eliminating bottlenecks.

Let us look further into the reasons for increased demand on the part of molders. Although there is certainly some inflation in this demand there must be further reasons why the molding and extrusion industry has a potential consumption so far in excess of the increased material supply. Let us take thermoplastic molding materials as an example and compare the number and size of injection and extrusion machines now in service with those in use in 1941. The actual number of machines in service at any one time or during any given year is estimated from the reports of deliveries. The 1947 figures are based on orders now in the hands of the machine manufacturers which are expected to be filled within the next year and a half.

You will note that by 1947 the number of injection machines will have increased by a ratio of 3.4 to 1, and the average size of the machines in service will have increased from 6 to 10 ounces. While the number of extruders in service in 1941 is not known, the number estimated to be operating on plastics by 1947 will be 1094. It is further estimated that the average size of the extruders will be about $3^1/_2$ in. diameter.

Then there are other reasons why the demand for material is so great. In addition to the greater number of injection machines with larger average capacity, there is the increased efficiency of the machines to consider. For the most part, today's machines have a faster stroke, better cylinder design, improved heat control and more rugged construction.

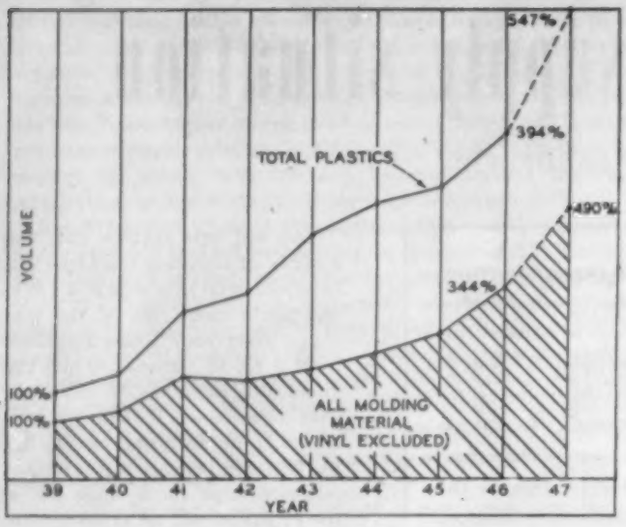
Year	*Injection machines*		*Extruders*
	Number	*Average rated capacity oz.*	*(Excluding rubber machines)*
1941	1000	6	Unknown
1944	1450	8	650
1945	1720	8	844
1946 (1st half year)	2044	9	. . .
1947 (Estimated)	3423	10	1094

There is less outage from breakdowns. Further, the average order received by a molder is much larger than it was in 1941 and he can make longer runs with less time out for changing molds and materials. Last but not least, most plastic materials today are better and more uniform than they were prewar. I would estimate very roughly that these three factors taken in the aggregate have increased the potential capacity by at least 25 percent.

Still another factor has definitely increased the demand on the part of the molders. Encouraged to step up the hours of operation during the war it is natural that molders want to continue on a 2- or 3-shift basis compared to the one, or one and a fraction, which was operated prewar. The longer hours are almost necessary if the growing overhead is to be spread out. Although I admit that my statistics are far from complete, I believe that the average hours of operation have increased 50 percent.

So far we have not considered the impact of the extrusion demand. Roughly speaking, the number of extruders in operation in the past and planned for the future is about one-third the number of injection machines. Approximately half the plastic-type extruders are running on vinyl materials and they must be excluded from this comparison because vinyl materials are not included in the molding powder production figures. Extruders generally operate 24 hr. a day as compared to 16 hr. for injection machines. The average extruder will consume three times as much material as the average injection machine. Therefore, to calculate the potential extrusion capacity for molding powder as related to the injection molding capacity, we start with one-third of the number of machines and take 50 percent of this total. Multiplying by 3 for the machine capacity and by 1.5 for the additional hours, we come out with a factor of 75 percent. In other

*Presented before the 1946 Conference of the Society of the Plastics Industry.
†President, Plastic Materials Manufacturers Assoc. and Vice-President Celanese Plastics Corp.



1—*Plastics production (excluding certain synthetic resins). Figures represent percentages with the year 1939 as 100. Editorial note: For the benefit of its readers, Modern Plastics research staff has delved into production statistics in order to ascertain the meaning of these percentages on a poundage basis. Past statistics on plastics are confused, incomplete and often conflicting, but the figures for 1939 assembled here from government sources are deemed reasonably accurate with a small margin of error not deemed sufficient to upset trends. Production of synthetic resins in 1939 totalled 213 million lb. of which between 85 and 95 million were phenolic and urea. This amount, when added to the cellulosics production, plus a few million pounds of other synthetic resins that found their way into the plastics industry, gives a total of approximately 135 million lb. To this should be added 15 million lb. to include fillers not otherwise accounted for. Thus the base figure for 1939 is 150 million lb. The amount of thermoplastic molding powder plus the thermosetting molding powder produced in 1939 was roughly 100 million lb.*

words, the extrusion demand alone amounts to three-quarters of the injection molding demand.

Now let us look at the available supply of thermoplastic molding material. If we take 1939 as 100 percent, by 1941 the production had reached approximately 300 percent. Today at the end of the first quarter of 1946, it is approximately 750 percent. The ratio is 2.5 to 1 compared to 1941. By 1947 we expect it to reach 1730 percent which will be 2.3 times the current rate of production. In spite of these increases the supply today is totally inadequate and I believe we will have the same situation next year.

Figure 4 shows these figures in graph form. The basic injection molding capacity as shown is calculated from the number of machines and their rated capacity. Superimposed on this at the right hand side of the chart (represented by the cross-hatched area) is the effect of the 25 percent increased efficiency. Up to that point there is relative equilibrium even into 1947. The dotted line which runs consistently above the material supply line is based on adding 50 percent to the previous capacity as represented by the increased hours of work. The top line has been plotted to represent the extrusion demand superimposed on the previous total. By comparing this top line with the material supply line we will find that the ratio of demand to supply today is 2.4 to 1 and, instead of getting better next year, it will be 2.6 to 1, if all the new injection and extrusion machines are delivered on schedule. The material suppliers, as stated before, report a current demand ratio of 3 to 1 and it might be assumed that approximately one-sixth of this is duplication or inflation.

This same condition, although to a lesser degree, is true also in compression molding. In calculating the growth ratio in press capacity from 1941, I have shown in Table I a modified ratio which, from 1946 on, allows for 50 percent increase in efficiency due to two factors—1) use of electronic heating and 2) longer hours of operation. No supporting data can be found for this factor although it is based on the average of several intelligent guesses by informed members of the industry.

Table I.—Thermosetting Molding Material (Estimated ratio of molding capacity to material supply)

Year	*Number of compression presses*	*Ratio*	*Modified ratio Up 50%*	*Material supply index*
1941	8,000	1.0	..	1.0
1944	11,500	1.44	..	1.0
1946	12,065	1.50	2.25	1.33
1947	12,867	1.60	2.40	1.80

The material supply remained constant for several years and, after the 1947 increase is realized, the output will be approximately 75 percent of the demand.

Film is just as critical as molding material. Apparent demand exceeds production by even 4 to 1 in some cases. Sheets, rods and tubes, with the exception of vinyl butyral, are bad enough with the demand running 2 to 1. The only forms where the supply is at all adequate are adhesives and some types of laminating varnishes. Lack of flexibility in producing equipment makes it impossible to switch production to any extent from one form to another. The production of adhesives has been cut temporarily in some instances to divert the raw material to molding powder.

Reconversion and planned increase

It did not take long for either the material producer or the molder to switch from war- to peacetime goods. However, in working out the national reconversion problem it was natural to begin everywhere at the consumer level. As each producer of consumer goods orders his parts and materials the impact is passed on to the parts manufacturers and then to the material manufacturers and still on to the basic raw materials producer. The material supplier is one step farther removed from the consumer than the molder. We, the material manufacturers, have to purchase our own raw materials at a level closer to the prime source and there are grave doubts in my mind that this supply of raw material would be adequate today to meet increased plant capacity if by some miracle we could bring this suddenly out of a hat.

Plastic materials today represent so large a percentage of the chemical industry that any sizable expansion on our part requires expansion in the production of such chemicals as phenol, formaldehyde, urea, acetylene and acetic and other acids, benzol, chlorine, bleached alpha cellulose, etc. Therefore, to increase the supply of plastic materials requires time, money and planning.

In December 1945 the PMMA conducted a survey of its members which summarized all the plans for new plants. The expenditure involved was estimated at 107 million dollars. It was thought that these plans would require approximately a year and a half to execute and that by July 1, 1947, we would have available from 250 to 300 million lb. per year of additional material. These plans are going forward as rapidly as possible, but there have been delays, and it is going to cost more in plant investment than was originally estimated, by at least 20 percent. Allowing for those plant expansions that would not necessitate the addition of fully balanced capacity, it is probable that our expenditures may run in excess of $125,000,000.

If you will refer to Fig. 1, you will see the growth curve for all plastics and the percentage which is in the form of molding ma-

terial from 1939 to date, as well as the projected increases for 1947. Both lines are in percentages with the year 1939 as 100. The total does not include certain synthetic resins such as the alkyds, coumarone-indene, etc., which usually do not find their way into plastics as we know them. By mid-1946 the total output of plastics will have gone up to 394 percent and by the middle of 1947 we anticipate the curve will reach 547 percent. On the same basis, all types of molding powder combined will reach 344 percent by the middle of the current year and 490 percent by 1947. Vinyl resins are excluded from the molding material but are included in the total. The reason for this is that the percentage of vinyl plastics produced for molding powder is relatively small.

The figures obtained from the individual members of PMMA are confidential to our General Manager, Frank Carman. For purposes of clarification, after allowing for the shipments percentage not produced by PMMA members, you can assume that the output of total plastics as represented by the top curve was 500 million lb. in 1945. Correspondingly, the output of molding material was 250 million pounds.

What does this mean in terms of anticipated increases over the first quarter of 1946? Roughly, it means that by some time in 1947 the total plastics output will go up 50 percent and molding powders alone approximately 62 percent. This might be a good place to answer the question recently asked, "What percentage of the overall output of PMMA members goes to customers in that segment of the industry not generally represented in S.P.I.?" Our recent survey shows that S.P.I. members take over 90 percent of the molding powder but only 59 percent of the total production of plastics in all forms.

Molding materials output

Figure 3 shows three of the principal molding materials—phenolic, urea melamine and cellulosic. These also are expressed in percentages with the year 1939 as 100. The chart shows that today cellulosic molding material is running in excess of 500 percent and the other two in the neighborhood of 200 percent. We anticipate that the 1946 production of cellulosics will be nearly 600 percent and the other two 250 percent. By 1947 cellulosic material will be available at the rate of 800 percent, urea melamine at nearly 350 percent and phenolics at nearly 300 percent.

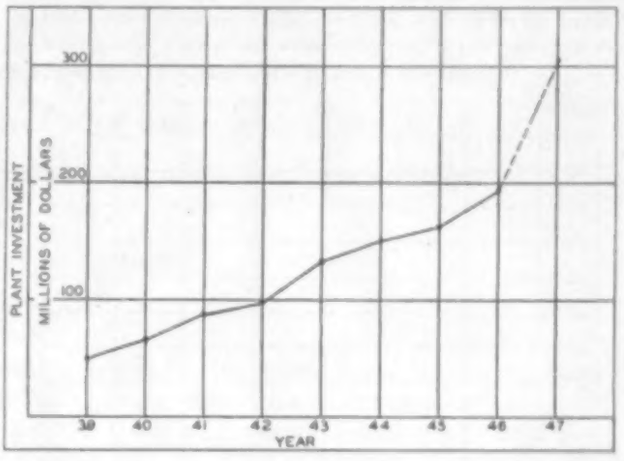
I know that there is great interest in polystyrene. It is wellnigh impossible to represent this on a graph without using logarithm tables. Again taking 1939 as 100 percent, the 1945 production was over 32 times as great. By the middle of 1946 the output will be again doubled, and by 1947 it is anticipated to be 6 times as great as in 1945.

In the acrylics, plans for the future are less concrete. The 1945 production was almost 50 percent greater than 1944 and the 1946 estimated production will be over twice as great as 1945.

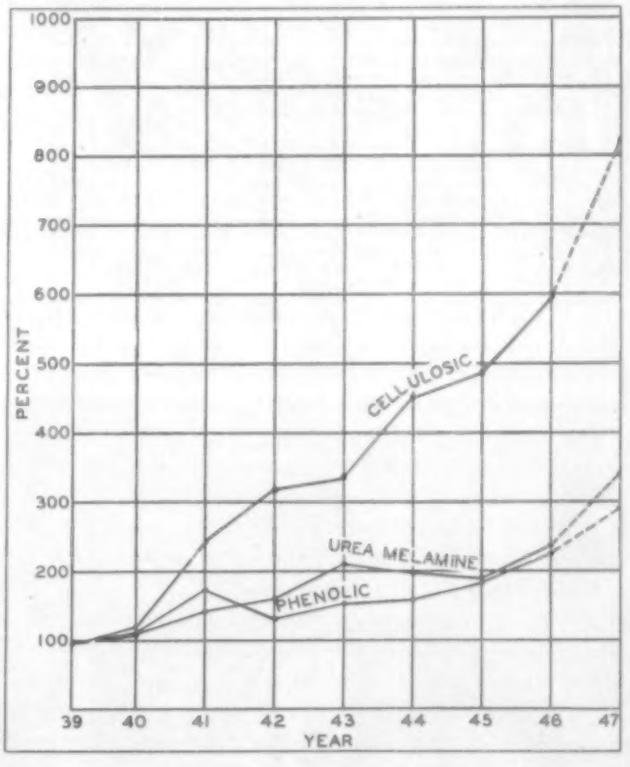
Referring again to Fig. 4 on thermoplastic molding materials, I might state here that it is my belief that if these figures are regarded as reasonably accurate, the producers of thermoplastic molding materials will be encouraged to plan further additions at an early date without fear of over-expansion.

Figure 2 shows the estimated investment in plant and machinery for the production of plastic materials. Again certain synthetic resins are excluded. It is difficult to draw a sharp line between the plastics facilities and some of the chemical operations of the larger producers. My estimate is based not on reports from the producers themselves, but on the average cost of facilities for a complete plant expressed in terms of its annual capacity. Excluding working capital, accounts receivable, material inventories and everything except the bare plant and its equipment, these costs have risen gradually from approximately 30 cents per pound in 1939 to over 40 cents today. It is probable that a complete new plant erected today would cost 50 cents per pound year. The total investment today is close to 200 million dollars and by the time the present planned expansion is completed will exceed 300 million. The increases shown during the war years were largely in vinyls, vinylidene, acrylic sheet and polyethylene.

The one thing that we cannot be sure of is the time schedule in carrying out the above plans. The members of the PMMA report to me that they have already been set back from 2 to 4 months largely because of strikes. I feel that the strikes are not over and that the coal situation may have far-reaching effects, not only on many of our current raw materials, but on construction and building of machinery. Indeed, the possibility of strikes within the industry must not be discounted. Another factor which we cannot yet evaluate is the effect of the Directive restricting industrial building. I do not wish to appear pessimistic, yet at the same time I cannot hold out what might be false hopes



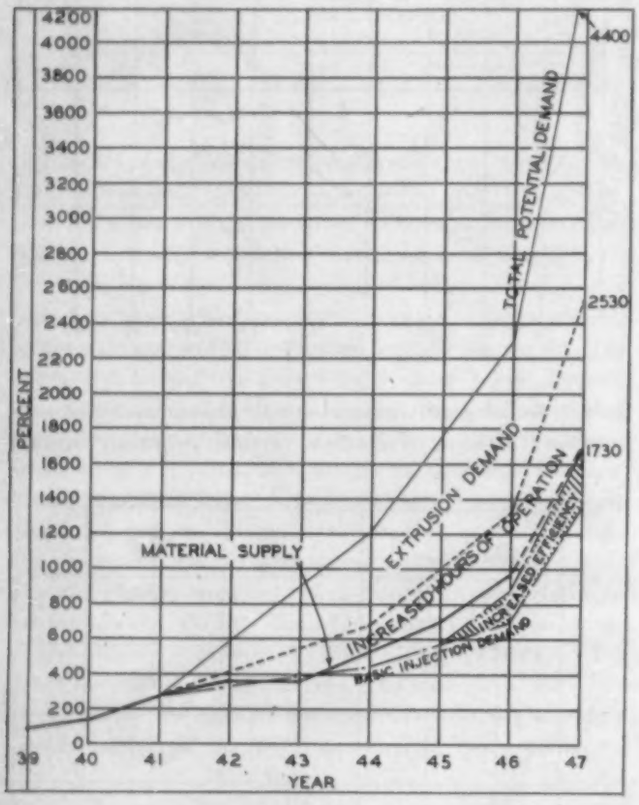
2—Estimated plant investment in plastic material production facilities (excluding certain synthetic resins)



3—Principal molding materials output by years in percentages with 1939 taken as 100. Polystyrene and acrylic are not shown. Editorial note: Production of phenolic molding material, 1940, about 80 million lb.; urea and melamine, about 18 million lb.; cellulosics, about 15,500,000 lb.

for early relief in 1946. There are a few bright spots. Polystyrene is coming to the rescue and will be one of the first plastics to appear in the form of sizable increases. The shortage of labor in the producers' plants has cleared up in most cases. One of our worries is the supply of raw material.

In the case of phenolic molding materials, the wood flour supplies appear to be improving but there is still an overall shortage and in some instances it is questioned whether or not the expansions now being put through can be maintained. The steel strike has caused an acute situation in the case of those plasticizers based on phthalic anhydride. Several weeks' production were lost, and if the coal strike continues, further shortages can be anticipated. The supply of urea at the present time is not holding up production, but many of the expansions are based on the increased requirements for urea which may or may not be available at the proper time. Other critical shortages at the moment include maleic anhydride, cresols and cresylic acid, certain coloring pigments for thermoplastics and cotton linters. There is an overall shortage of cellulosic flake for molding powder and sheet production.



4—Production of thermoplastic molding material in percentages with 1939 as 100. Reading from bottom to top:

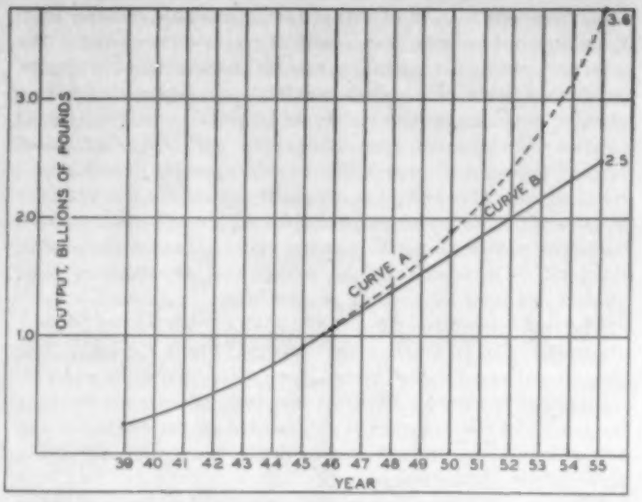
The bottom line shows the amount of raw material that would be consumed with all machines running at normal capacity as determined by prewar standards.

The space marked "increased efficiency" represents the increased production after 1945 due to better materials and improved efficiency of machines.

The heavy line "material supply" represents actual and projected production of all molding materials except vinyl.

The space marked "increased hours of operation" indicates how much more raw material is needed when working hours increase from 8 to 10. The light dotted line thus shows the total demand of raw material for injection machines when all are working on a 16-hr. day.

The space between the light dotted line and the top line is the amount of material that will be used for extrusion of thermoplastics exclusive of vinyl. The top line thus shows the total demand for thermoplastic molding powders



5—Projected growth in output of plastic materials (including all synthetic resins)

Curve A—Dr. Gaston Dubois says raw material production will double every 5 years for the next ten. By 1955, production would be 3,600,000,000 lb.

Curve B—This line shows increase at uniform rate comparable to slope of curve at 1945. Production in 1955 at this rate would be 2,500,000,000 lb.

Probable future growth

You are probably all asking the question: "Why do we stop with the plans already announced which will add 250 million to 300 million pounds of annual capacity?" The answer is that we do not intend to stop but before we can plan for further increases, the immediate ones must be accomplished. It may take five years for the material supply to again reach equilibrium with the molding and fabricating capacity, but it is our objective to bring this about as quickly as possible. Of course, if the molders continue to add equipment at the rate indicated it may take longer.

Where will the industry be ten years from now? Such an eminent authority as Dr. Gaston Dubois of Monsanto has predicted that it will double itself every five years for the next ten. I have attempted to show this on Fig. 5. To tie it to other published statistics, I have included in this chart all synthetic resins which, combined with the output of plastic materials, reached a total production of 900 million lb. in 1945. If Dr. Dubois is right we should reach a capacity of 3.6 billion lb. by 1955. As an alternative I have shown on the chart a line tangent to the previous growth curve at the 1945 level on the basis of a straight arithmetic progression. This brings us out to 2.5 billion lb. by 1955. Perhaps the actual will fall somewhere between these two.

Lest you find these long-range predictions over-enthusiastic, let me issue one warning by pointing out that they are long-range predictions and that the already critical supply situation must not be under-estimated. I cannot encourage anyone who is not now a molder, extruder or fabricator, or a processor of plastics in any form, to enter this field until supplies do become available—not in one or even five years. The established molders and fabricators with the most excellent ratings and with sources of supply will have enough difficulties keeping their plants in operation, at least at desirable levels. Any newcomer would find himself hard put to get plastic materials.

The duplicating of plastic molds**

Duplicating machines, a valuable supplement to hobbing and milling in the production of mold cavities and force plugs, are of 3 basic types—manual, electric finger-tip controlled and automatic

by ISLYN THOMAS† and JOHN HOHL‡

AT one time the designing and production of a mold was left to the individual skilled toolmaker who used the general-purpose equipment available to him. Management paid little attention to the problem of securing special equipment which would reduce mold costs and thus pave the way to an enormous extension of use and greater diversification of molded products.

Today, experienced tool shops specializing in mold making must consider the quickest and most economical way of producing good-operating, dimensionally correct molds if they are to insure a more favorable competitive position. In consequence, the alert plastic mold shop places high value on new applications which will speed up old methods of machining, eliminate slow hand work and produce a more accurate output in the most economic way.

This change in attitude has resulted in the introduction of duplicating machines and hobbing presses to supplement the general-purpose machines considered standard equipment in the average tool room since this equipment provides the best means of producing identical cavities in multiple-cavity molds of irregular form and contour.

DUPLICATING PROCEDURE

For reasons of economy the average tool shop does not have a large-size hobbing press. It follows that,

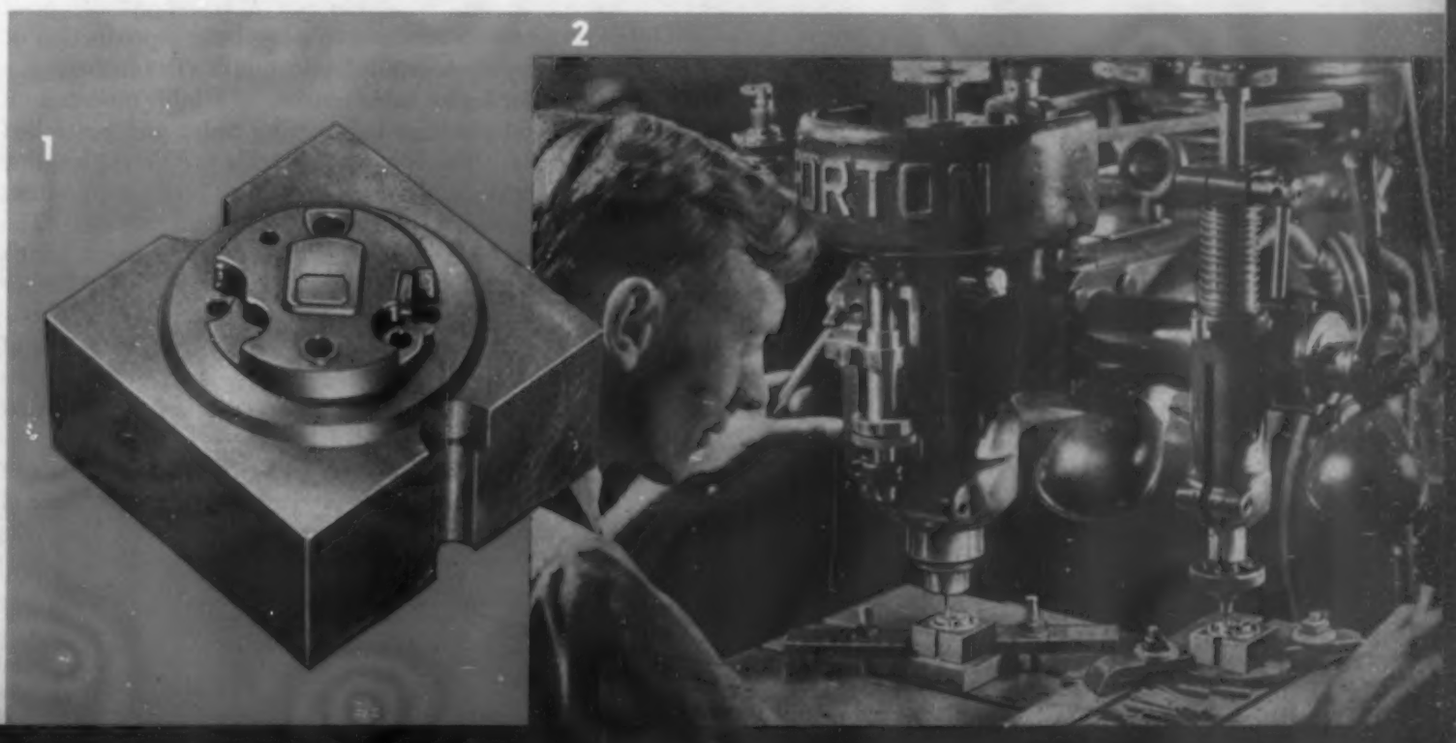
* Reg. U. S. Patent Office.

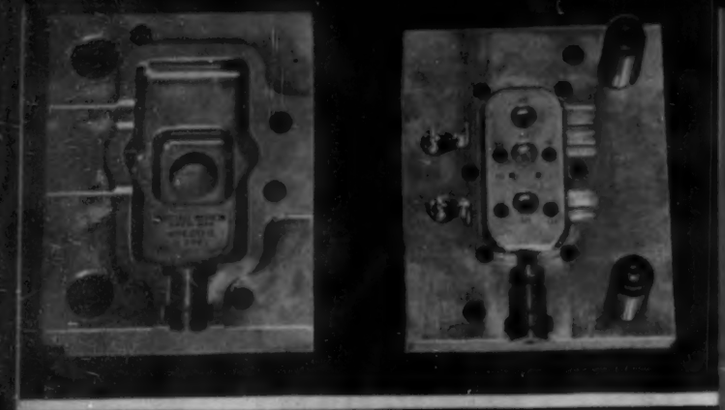
** This article together with several others by Mr. Thomas, which have appeared in previous issues of MODERN PLASTICS MAGAZINE, comprise part of a book on injection molding which is being written by Islyn Thomas and will be published in the Fall by Reinhold Publishing Co.

† President, Thomas Manufacturing Corp.

‡ President, Newark Die Co.

1—This force plug is an example of work that is best done on a duplicating machine. 2—Here the master pattern for the force shown in Fig. 1 has been set up and is now ready for duplicating





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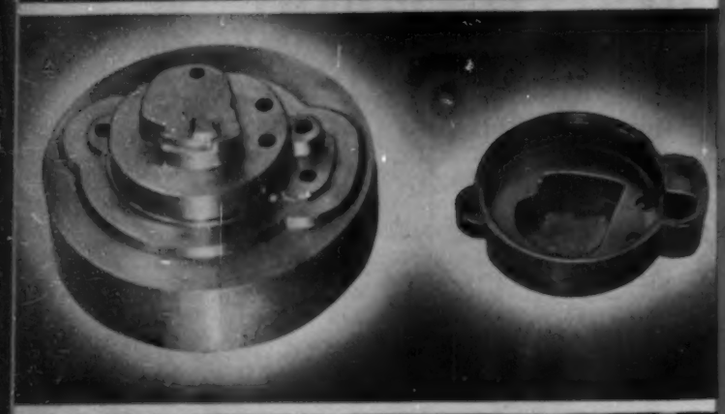

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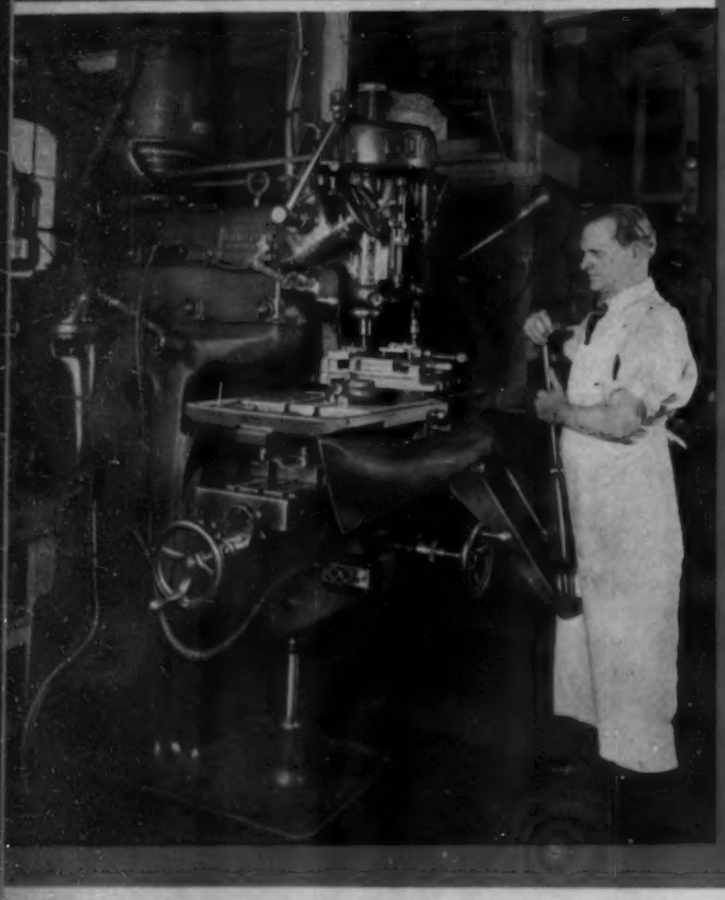

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3—The hobbing method was indicated for producing cavity at left, while duplicating is the practical and economical method of producing the force plug at right. 4—Duplicating machines are particularly useful for the repetitive production of many identical force plugs. 5—Basically, this manually controlled machine is a vertical miller with duplicator table and tracer head added

at times, the projected area of the proposed master hob proves to be much too great for the available equipment. For shops that fall in the above category, duplicating is the next best method of achieving the desired results. Further, some cavities cannot be satisfactorily hobbed because means for the escape of the metal as it is displaced are insufficient. When hobbing is impractical and the work too complicated for straight milling, as in the case of the force plug shown in Fig. 1, duplicating from a master pattern (Fig. 2) will produce by far the best results.

The duplicating machine is not a cure-all and cannot economically produce a large number of cavity blocks of the type shown in Fig. 3—the hobbing method being far more practical and economical for work of this nature. However, in making the force for this mold (also shown in Fig. 3) the duplicator can be used to considerably more advantage than any straight milling or hobbing procedure.

Duplicating machines, of particular value on repetitive multiple-cavity work such as is involved in the production of force plugs like that shown in Fig. 4, can be used with economy in many other types of work, as in the production of single cavities or master hobs. A model or template can be made of easily worked materials, then duplicated to produce a cavity or hob of such size, complexity and accuracy as could hardly be achieved by other methods. Even if the full cost of a master is added to the cutting time on the machine, the result often represents a substantial saving in costs to the company.

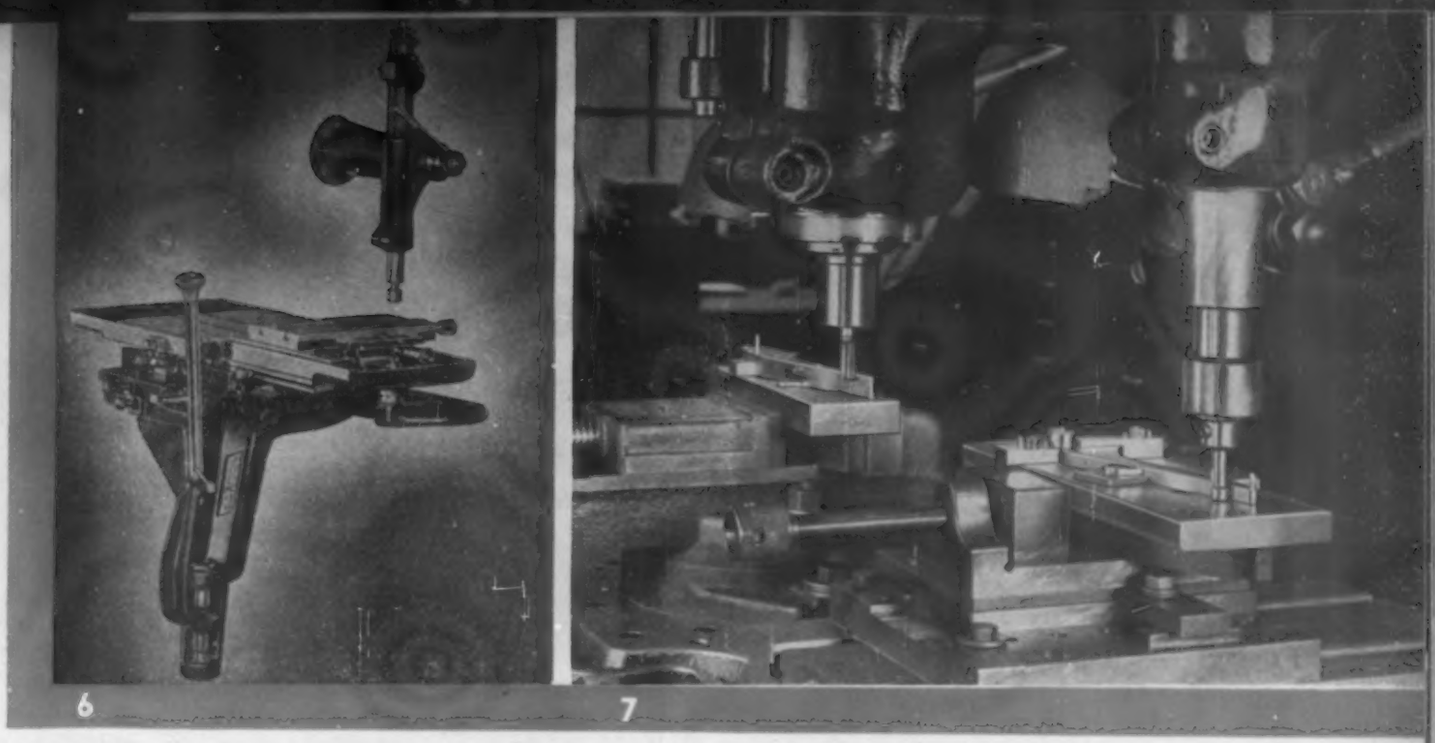
There are three basic types of duplicating machines—the manual, the electric finger-tip control and the automatic. All are capable of either two-dimensional or three-dimensional work.

MANUAL CONTROL DUPLICATOR

The Gorton duplicating machine, shown in Fig. 5, is virtually two machines in one. Basically, it is a vertical milling machine and can be used for either vertical milling operations or duplicating, whichever is desired. It differs from plain milling machines in having a sensitive table and a tracer spindle head (Fig. 6) which combine to permit the reproduction of nearly any shape or the duplication of a flat master.

The duplicator table consists of a table mounted on compound-precision ball-bearing slides and controlled by a lever. This lever is adjustable to different lengths, thus permitting the most convenient operating position and a variable leverage for heavy or light cuts. The sensitiveness of the table and tracer spindle permits the operator to duplicate work to a tolerance of 0.001 in. or closer since he is thus able to keep the tracing style constantly in contact with the master. The degree of sensitiveness in the tracer spindle feed lever can be varied quite readily by means of an adjustable spring compensator.

The cutter spindle is designed for a wide range of speeds, and can easily accommodate various sizes of cutters. It has been found that in duplicating, the



6—A vertical miller, when added to this tracer spindle head and duplicator table, convert it to a duplicator which can be worked to a tolerance of 0.001 inch. 7—By varying the diameter of the tracing style in relation to that of the end mill used in the cutter spindle, the size of the work may be made either smaller or larger than that of the master or the template which it duplicates

rate of cutting feet per minute should not exceed that generally used in plain milling. The limitation on higher feeds is due not so much to the lack of control but the want of better cutting tools.

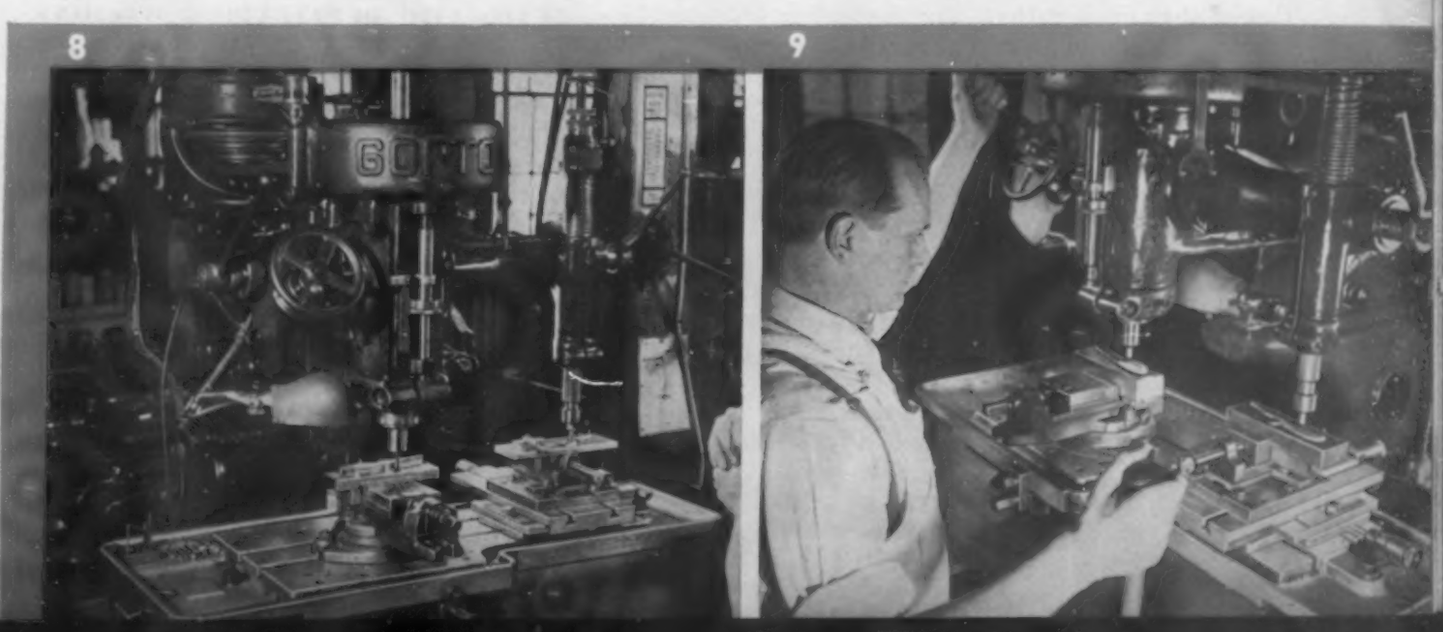
Profiling in two dimensions

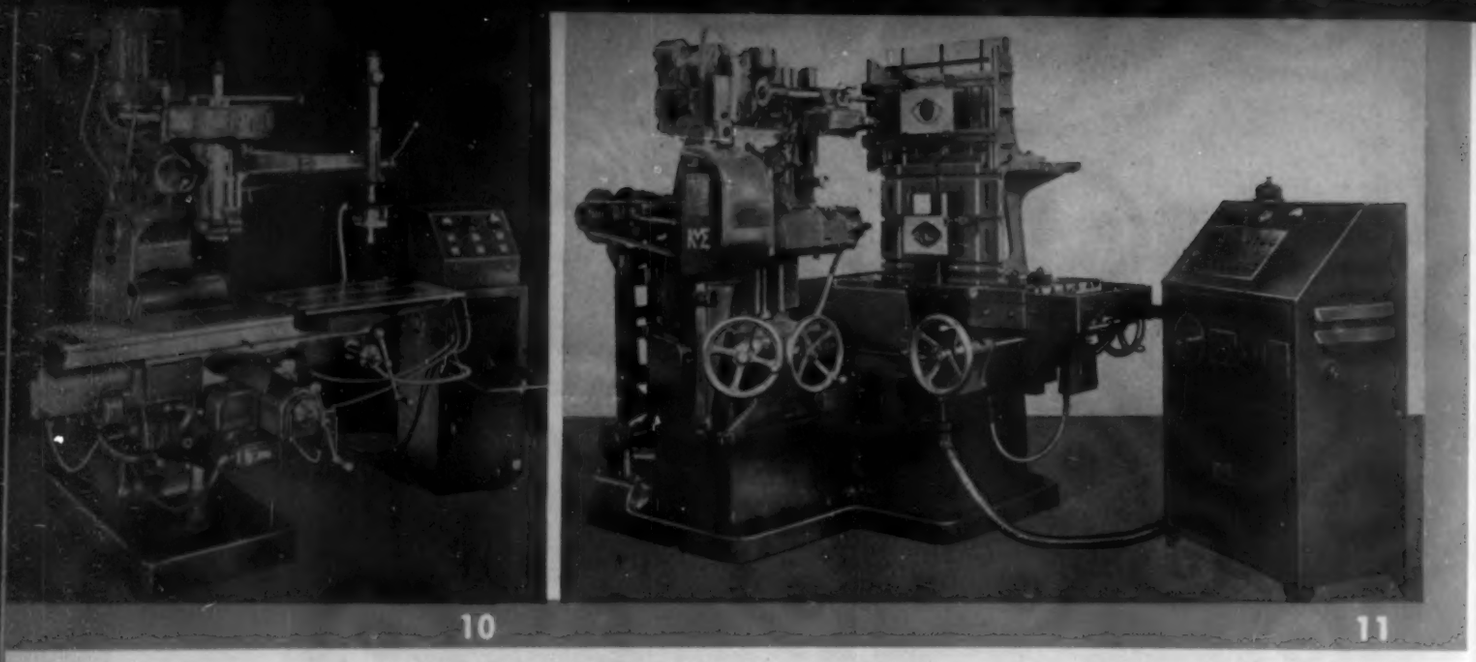
On a manual control duplicating machine, the master or pattern to be duplicated is placed on a master table mounted at the right-hand end of the duplicator table. Built-in micrometers aid in accurately setting the master in relation to the work. The tracer spindle head is mounted on the machine column parallel to the cutter spindle and is connected to the cutter spindle feed mechanism. The tracer spindle, as shown in Fig. 7, holds a tracing style whose diameter has a direct relationship to that of the end mill being used in the cutter spindle.

When it is necessary to reduce or increase the size of the work being cut in comparison with that of the master or template, the diameter of the style is either increased or decreased in relationship to that of the cutter. In this way force plugs may be cut using the cavity block master hob as a guide—the style being reduced in diameter to compensate for the wall thickness of the finished molded part.

In two-dimensional duplicating (Fig. 8), the operator generally places both hands on the lever which controls

8—In two-dimensional duplicating, complete control lies in a single lever. 9—When reproducing three-dimensional work with a manually controlled duplicator, an operator uses his left hand to control vertical movement of cutter and spindle, his right to direct the lateral movement of the table





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10—View of an electric finger-tip control duplicating machine which is so sensitive that an operator can maneuver the cutter around the most minute curves with only the slightest exertion. 11—*This automatic duplicator is actuated by electrically controlled power feeds operating in three directions*

the lateral movement of the duplicator table in any direction, thereby permitting the tracing style to follow the shape of the master being duplicated.

Three-dimensional duplicating

For manually duplicating in three dimensions, as shown in Fig. 9, the operator uses his left hand to control the vertical movement of both the milling cutter and tracer spindle; his right hand to direct the lateral movement of the duplicating table. Thus, he can raise and lower both cutter and spindle as the tracing style follows the contours of the master to be reproduced by altering the position of the lever held in his left hand. Since the tracer and cutter spindles are connected with a pinion shaft they move up and down in unison. Through the large lever which he grasps with his right hand, the operator controls the lateral movement of the duplicator table in any direction. These controls operating in unison cause the cutter to mill the die to an exact duplicate of the master.

In this way, any shape or contour can be duplicated full size or with slight variations depending on the relationship between the size of the tracing point and that of the milling cutter. The duplicating machine is not equipped with a modeling bar like that employed on a three-dimensional pantograph engraving machine.

ELECTRIC CONTROL MACHINE

The finger-tip control, which is the heart of the Gorton electrical duplicator shown in Fig. 10 and determines the table movements, is so very sensitive that the operator can maneuver the cutter in and out, around, or up and down at will without the slightest exertion. Although the controls can be set for either roughing or finishing by an adjustment of the electrical contacts, the sensitiveness of the machine, and therefore the exactness of cutting, is not materially affected. And should the operator remove his finger for a moment from the tracing style, the movement of the table will cease immediately, eliminating all chance of undercutting or over-cutting, as the case may be. Since this miller is of a vertical type, the setting-up operations are relatively simple and, from a cutting standpoint, the operator has absolute control and an unobstructed view of both the master and the job.

The natural question is "why not make the control of this machine completely automatic, freeing the operator of constant supervision." The consensus of opinion is that by tying the operator to the job he will, as it were, compete with himself on time, eliminating the chance of the cutter's passing into cavities that are already cleaned out and insuring its working in paths that are in need of further stock removal.

In the early operations on any piece of work, the largest-size cutter is employed whether the master is of a soft plaster, of wood or of a more substantial material. As the job progresses, smaller cutters are employed to facilitate removal of the stock from the smaller corners.

AUTOMATIC DUPLICATING MACHINE

An automatic duplicating or die-sinking machine, like that shown in Fig. 11, is actually a powerful horizontal milling machine in which up, down and lateral movements are operated by electrically controlled power feeds. These controls on the feed can be credited with the ability of the machine to reproduce automatically the shape of a master. The unit may either be used to profile in two dimensions or to reproduce reliefs in three dimensions. In either case a tracer passes over the master form and the cutter duplicates its path precisely in all details.

The cutting is controlled electrically to maximum cutter capacity regardless of the shape being duplicated.

The movements of the feeding mechanisms are regulated by electrical contacts in the tracer, and the amount of pressure exerted on the tracer point is a constant—measured in ounces and independent of the size of the job or depth of cut.

The tracer is mounted on a bracket above the cutter, the distance between the two being adjusted in accordance with the job to be done. From then on the tracer and cutter move in unison as shown in Fig. 12. The tracer follows the shape of the master form and the cutter duplicates that form in the work. This is achieved by a very light tracer contact and electric control, so that reproduction is very accurate.

Due to the delicacy of the electrical control, which permits the use of small cutters, the finest of work can be done on the very largest molds. The operator enjoys the same freedom and control as if he were merely following around a master without a cutter being employed. As size, within the range of the equipment, and shape are no barrier, almost any type of job can be applied to this machine, be it simple profiling work or the sinking of dies for the most complex shapes.

Profiling in two dimensions

For two-dimensional work on an automatic machine, a profile tracer is used which controls and guides only the vertical and horizontal movements of the machine. The cutter is set to a given depth before the operation is started. Ordinarily, a thin metal template is used as the master in this type of operation.

A case in point is the spiral in the mold shown in Fig. 13. Here the tracer point is in continuous contact with the master as it passes around it, guiding the path of the cutter in the accurate reproduction of the master shape in the mold. The back of this tracer carries four contact points, corresponding to the up, down, right and left directions. A very slight pressure of the tracer point against the master is sufficient to break one of these contacts and to make another. This make-and-break changes the direction of travel of the tracer by energizing or de-energizing various magnetic clutches which drive the movements of the machine.

During this profiling cut the operator is only required to guide the tracer point or style toward the master and to determine the general direction it should take in following the outline. This he does by means of a rotatable ring which is located at the back end of the tracer.

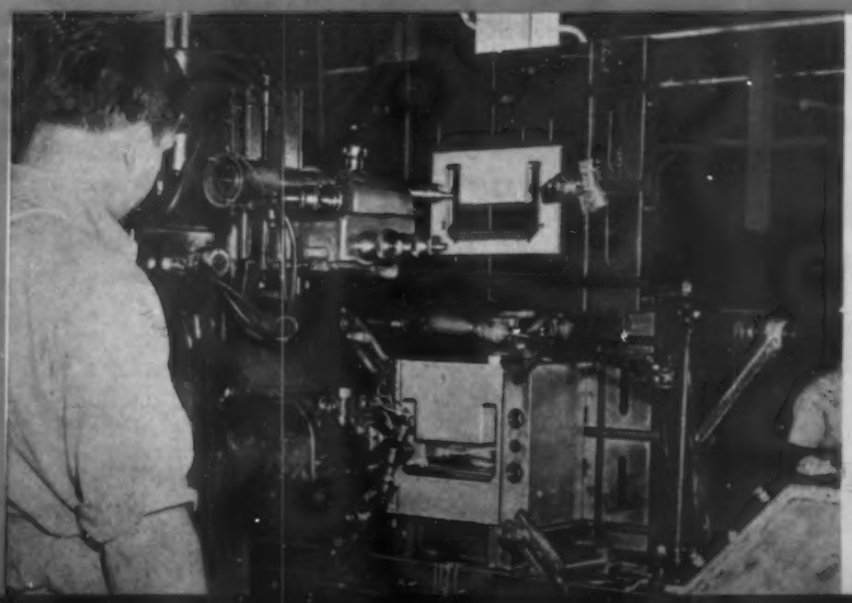
Three-dimensional duplicating

For three-dimensional duplicating (either relief or impression) an automatic tracer is used in place of a profile tracer. However, once the machine is set, it is fully automatic and requires no guidance from the operator as in the case of profiling work. The machine controls are set to cause the tracer (Fig. 14) to cover the entire surface of the master in a series of parallel strokes that move either up and down or from extreme right to left.

The lengths of these strokes are determined at the operator's option by adjustable table reversing dogs maintaining uniform length of stroke. This reversing motion can also be controlled manually with a reversing switch. At the end of each stroke an automatic cross feed takes place before the next stroke begins. The amount of this feed may either be determined in advance by a feed mechanism or it may be adjusted after each stroke. The third dimension is controlled by the automatic tracer. Before contact is established between the tracer and the model, as at the beginning of a job, the controls are arranged so that the only motion of the tracer and cutter is inward toward the work. But, from the moment contact is established, varying degrees of pressure on the tracer point (created by the contours of the model over which it passes) cause the

12—In the automatic duplicating machine, operation of the tracer and the cutter that moves in unison with it is achieved by a series of electrical contacts. *13—Cutting the spiral in this mold typifies the two-dimensional profiling work that can be done on an automatically controlled duplicating machine*

12

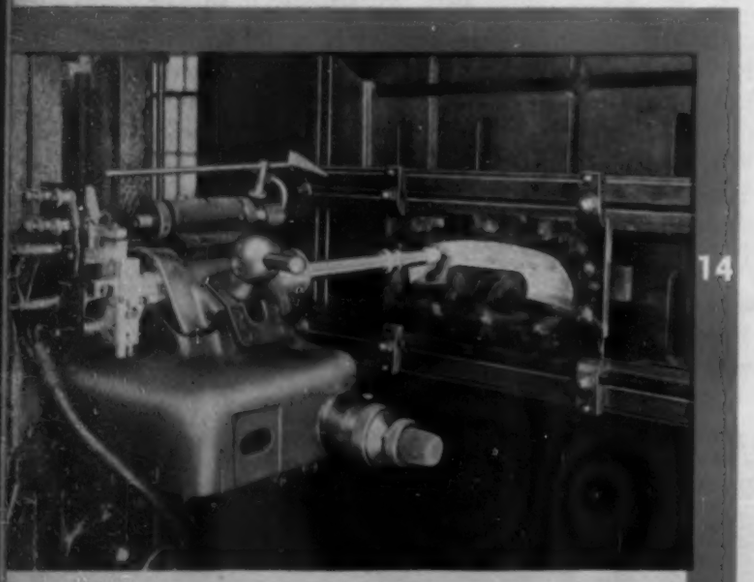


13

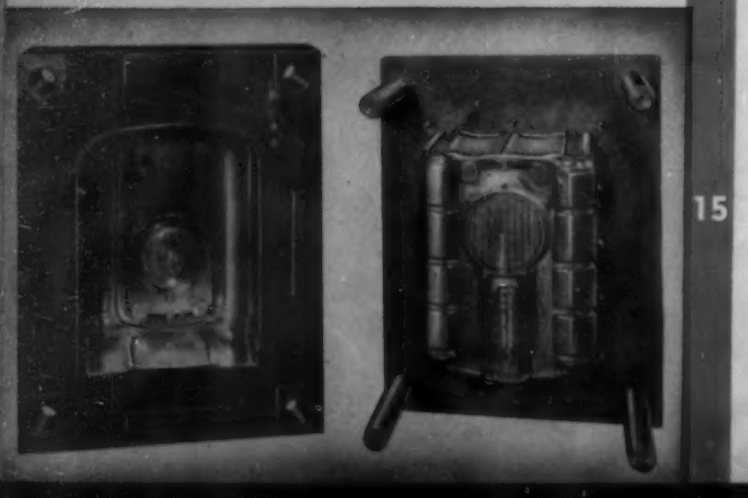
machine to travel in and out. The automatic tracer responds either to axial or side pressure. It is also controlled by interlocking relays which act to eliminate horizontal or vertical motion while the tracer is traveling either in or out. All this combines to assure reproduction of the complete form of the model no matter how steep the sides of its cavities or elevations may happen to be.

An example of a good automatic duplicating job is the radio cabinet mold shown in Fig. 15, which produces a cabinet measuring 18 by 13½ by 10½ inches. The cavity block is much too large for hobbing—hobbing equipment of the size necessary for this job being impractical. Both halves of the mold were cut from solid blocks of steel, approximately 560 lb. of metal being milled out in the process. Using this automatic duplicating machine, the removal of the metal was handled with economy since the horizontal position of the cutting spindle and the use of a constant flood of collant permit the ready removal of chips at the same time that the cutter continues to operate at its maximum efficiency.

14—In three dimensional cutting with an automatic duplicator, the tracer covers the entire surface of the master in a series of parallel strokes, their length determined by the setting of automatic reversing dogs. 15—An ideal job for automatic duplicating is this radio cabinet mold that measures 18 by 13-1/2 by 10-1/2 inches—too large for hobbing



14



15

The power feeds of this machine permit it to take cuts up to the full capacity of large cutters. In such work the cutter is protected from overload by an electrical feed control.

Many molds with sliding members and cam actions at different angles can be duplicated to advantage since the job need only be set up once on the machine while various cuts are produced from master templates or from straight edges. The machine that has been described is only one of a number of horizontal duplicating units that are available. Within the last few years, for example, hydraulic duplicating methods have been introduced in the field.

CUTTERS AND GRINDERS

Generally, there are two types of cutters used in duplicating—standard end mills, and double or single flute cutters (Fig. 16).

Standard end mills—Roughing cuts on duplicator work can be taken with standard end mills. The use of these mills is impractical, however, for semi-finishing and final finishing cuts as this work requires the grinding of odd sizes with many different angles, points and radii.

Single flute cutters—Single flute cutters have been found much superior to standard multi-flute cutters for the final finishing cuts since they can easily be resharpened or reground to other shapes, have greater strength and will stand higher speeds without burning.

These single flute cutters must be accurate and correspond exactly with the tracing style being used. Accuracy is of such paramount importance that a special grinder is used in place of the standard cutter grinder.

This special grinder (Fig. 17) is designed specially for single flute cutters which cannot be properly ground on the standard cutter grinders available. In complicated duplicating work, the cutters must be reground as often as 20 times a day to insure their accuracy. It is advisable, therefore, that the grinder be located as close as possible to the duplicator so that no unnecessary time will be lost in performing the numerous grinder operations.

MASTERS

Masters or templates used for profiling in a two-dimensional operation on a manually operated duplicating machine should be of metal, of heavy enough gage to withstand the manual pressure necessary to feed the cutter into the cut. When the depth of cut varies, a three-dimensional master must be used. This, too, is generally made of metal although in some cases artificial stone casts and phenolic casts have been used successfully. These last two masters are limited to jobs that do not have sharp edges and corners which tend to break down under the pressure of the tracer points.

Masters made from plaster of Paris are much cheaper but have not been entirely successful on manually

operated machines because they lack the surface hardness to bear up under the tracer points without grooving or breaking. Chipping and breaking can be prevented by the use of wood patterns, but here grooving cannot be entirely avoided even when the hardest woods are used. All in all, metal masters, though more costly to produce in respect to both time and money, are recommended for manually controlled duplicating machines.

For three-dimensional duplicating, on electric tip controlled or automatic duplicating machines as shown in Fig. 14, a wide variety of materials may be used for masters or templates. These include wood, cement, metals, cast phenolic, plaster of Paris or artificial stone. This is possible due to the sensitiveness and positive control of the delicate electrical mechanism. In fact the electrical control of these machines occasionally permits the use of celluloid templates for simple two-dimensional profiling where the master serves only to control the cross longitudinal movement which is made by the table.

TRACING STYLES

Round and square nose tracing styles are available in various lengths and diameters, as shown in Fig. 18, so that they can take care of the many types of master patterns they have to follow.

The tracer point (style) for the vertical duplicating machine is held in a collet with a draw bolt extending through the spacer spindle and is bottomed against a shoulder in the collet so it cannot slip endwise. The tracer spindle in both the vertical and horizontal machines does not revolve, thus eliminating practically all error due to eccentricity.

CONCLUSION

In evaluating the duplicating machine, it must be remembered that there are many cavities that cannot be produced by straight machining or duplication, and that there are others which would be prohibitively expensive if made in this manner. This is especially true of ornamental button designs, novelities, plastic bottle caps, knobs and dials for stoves and radios, and a great many other applications for both consumer and industrial use which are too numerous to mention here.

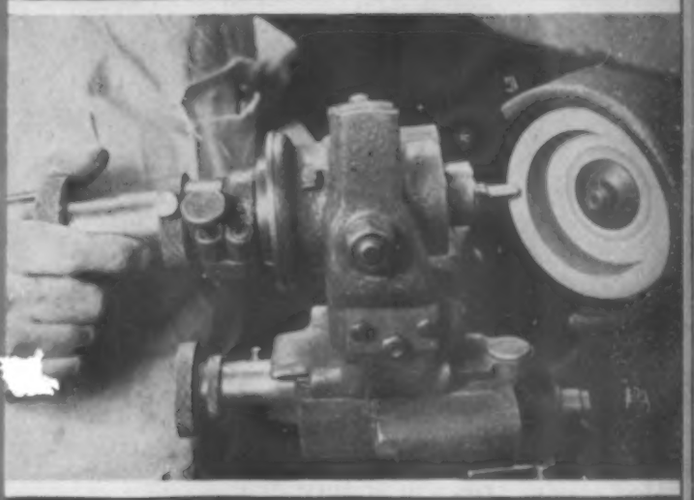
It is also a fact that many cavities may be produced more economically if both hobbing *and* machining procedures were used. Since the factors that control these variables are many, it is best that you place your mold problems in the hands of well-experienced toolmakers who have the necessary background and special equipment to give your mold the right kind of attention and construction so that it is completed as economically as is consistent with good workmanship.

PHOTOGRAPH CREDITS

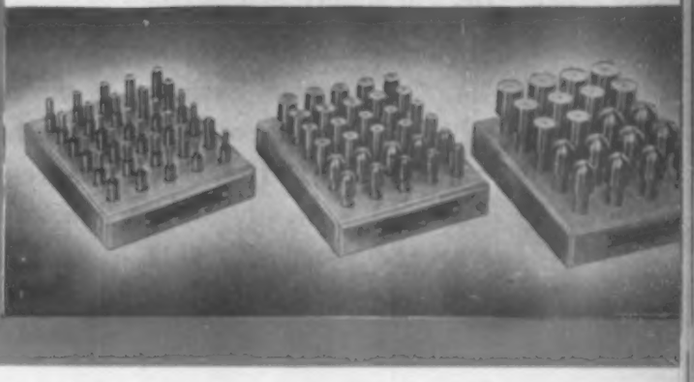
FIGURES 1, 2, 4, 6, 10, 16 AND 18, COURTESY GEORGE GORTON MACHINE CO. FIGS 3, 5, 7, 8, 9, 14 AND 17, NEWARK DIE CO. FIGS. 11 AND 15, PRATT & WHITNEY. FIG. 12, GENERAL ELECTRIC CO. FIG. 13, CONSOLIDATED MOLDED PRODUCTS CORPORATION.

16

17



18



16—The two general types of cutters used in duplicating are standard end mills, and double or single flute cutters. The first type is used for roughing cuts, the others for semi-finishing and final finishing operations. 17—*Since single flute cutters cannot be properly ground on a bench grinder, a specially designed grinder is necessary. Cutters must sometimes be reground 20 times a day to maintain accuracy, so it is advisable to keep the grinder near the duplicator.* 18—*Round and square nose tracing styles are available in a wide variety of lengths and diameters and can be used to handle many types of master patterns*

a Star is B

A new star on the lighting field horizon—the F. W. Wakefield Brass Company fluorescent fixture of Plaskon.

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A comparison of laminated materials

(see attached chart)

by J. C. PITZER*

THE Formica Comparator was developed to give on one sheet the relationship of all the various grades of laminated material. The various grades are, of course, produced from a variety of resins and fillers. It is difficult to compare these different materials by tables expressing actual values for the numerous physical properties of all grades. For this reason recourse was made to a comparison in which the various properties are evaluated by numbers running from one to ten.

The many properties of these laminates, such as water absorption, mechanical strength, etc., were determined by standard American Society for Testing Materials test procedures. The results were then arranged in numerical order and the corresponding comparator figure determined. In cases where no specified test existed for the determination of a property, as in the case of punching quality, knowledge gained from years of experience was used in arranging the grades in their order of quality.

In general, the various grades are grouped in accordance with their ultimate end use application. That is, all the paper grades are intended for electrical purposes; the fabric base grades are intended primarily for mechanical applications with the electrical consideration of secondary importance. It was not always possible to hold with this grouping since there are certain fabric base grades which have some electrical properties equal to the best of the paper base grades. The asbestos and glass cloth base grades are generally considered the most heat and fire resistant. It is impossible to pick out any one grade having all outstanding properties. In nearly every case a grade which is outstanding in one characteristic is likely to be deficient in certain other properties.

The utility of the Formica comparator chart depends on the consumer having a thorough knowledge of the ultimate application in which he intends to use a thermosetting laminated material. In this use determination, such requirements as insulation qualities, mechanical strength, heat or chemical resistance should be considered. After settling on the requirements, the user can then examine the chart for the particular property on which major emphasis is to be placed to determine the grade or grades most likely for the application in question. After the field has been narrowed down to two or three grades, all other properties to be considered should then be examined and a final decision made on the material having the best balance of properties.

* The Formica Insulation Company.

COMPARATOR CHART GIVING RELA

LEGEND: GRAD
CATES VALUES

GRADE	X	X-3	X-74	XP	XP-48	XP-73	XX	XX-2	XXP-5	XXP-7	XX-23	XXP-71	XXP	XXP-20	XXP-96	XXW	XXX	XXXP	C	CG	CH	CHR-5	CH-7
STANDARD SPECIFICATIONS	NEMA			NEMA		JAN-P-13 LTS-E-1	NEMA				JAN-P-13 LTS-E-2		NEMA	JAN-P-13 LTS-E-3			JAN-P-13 LTS-E-4	NEMA	NEMA					
BASE	KRAFT PAPER	KRAFT PAPER	FLEXIBLE PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	PAPER	COARSE FABRIC	COARSE FABRIC	MEDIUM FABRIC	MEDIUM FABRIC	COARSE FABRIC
TYPE RESINS	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC
MAJOR CHARACTERISTICS:	MECHANICAL APPLICATION	DOORLESS	BONDING	PUNCHING	SHEARING	COLD PUNCHING	GENERAL ELECTRICAL APPLICATIONS	HIGH DIELECTRIC PARALLEL TO LAMINATIONS	UNIFORM MACHINING OR SANDING	CHEMICAL RESISTANT	GENERAL ELECTRICAL APPLICATION	X-RAY CASSETTES	PUNCHING	PUNCHING	PUNCHING AND SHAVING	HOST WATER RESISTANT PAPER BASE	HIGH IMPREGNATION LOW COLD FLOW	LOW LOSS HOT PUNCHING	HIGH IMPACT MECHANICAL APPLICATION	GEARS	BETTER MACHINING GRADE-C	MOISTURE RESISTANT	PLATING BARREL APPLICATIONS
SPECIFIC GRAVITY	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.34	1.36	1.36	1.36	1.36	1.36	1.36	1.32	1.34	1.34	1.36	1.36	1.36	1.36	1.36
PROPERTY																							
WATER RESISTANCE	1	3	1	2	2	2	7	7	7	8	7	8	7	7	7	9	8	8	4	4	4	7	6
DIMENSIONAL STABILITY	1	3	1	1	1	1	6	6	6	7	6	8	5	5	5	9	7	7	4	4	4	6	5
INSULATION RESISTANCE	1	*	1	2	2	2	8	9	5	2	8	8	7	7	7	*	9	8	1	*	1	1	1
DIELECTRIC STRENGTH PERPENDICULAR TO LAMINATIONS	8	*	8	8	8	8	10	10	9	2	10	9	10	10	8	*	9	9	1	*	2	1	1
DIELECTRIC STRENGTH PARALLEL TO LAMINATIONS	2	*	*	6	6	6	8	9	8	2	8	8	6	6	5	*	8	8	2	*	2	*	*
DIELECTRIC LOSSES RADIO FREQUENCY	2	*	1	4	4	4	6	6	5	*	6	6	5	5	5	*	7	8	1	*	1	*	4
DIELECTRIC LOSSES POWER FREQUENCY	7	*	6	5	6	5	6	7	6	*	6	6	7	7	7	*	8	8	2	*	2	*	*
ARC RESISTANCE	3	*	3	3	3	3	2	2	2	*	2	2	2	2	2	*	1	2	2	*	2	4	4
STABILITY OF ELECTRICAL PROPERTIES ADVERSE CONDITIONS	1	*	1	2	2	2	8	8	7	*	8	8	4	4	4	*	9	9	1	*	1	*	*
MECHANICAL STRENGTH	6	6	5	1	1	1	5	5	5	4	5	5	2	2	2	3	3	3	6	6	5	5	6
IMPACT STRENGTH	2	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	4	3	3	4
BONDING STRENGTH	3	3	*	1	1	1	3	3	3	3	3	3	*	*	*	3	3	*	8	8	8	8	8
MACHINABILITY	4	4	3	6	6	6	5	5	5	5	5	5	5	5	5	4	4	5	7	7	8	8	7
PUNCHING	5	5	8	8	8	8	5	*	5	*	5	5	6	6	8	*	1	5	8	*	8	8	7
WEAR RESISTANCE	5	5	4	5	4	4	8	8	8	8	8	8	7	7	7	7	7	7	10	10	10	10	9
HEAT RESISTANCE	2	2	1	1	1	1	2	2	2	2	2	2	1	1	1	1	2	1	3	4	3	3	3
CHEMICAL RESISTANCE																							
ACIDS	*	*	*	*	*	*	1	1	*	4	1	*	*	*	*	8	2	*	3	3	3	5	4
ALKALI	*	*	*	*	*	*	1	1	*	2	1	*	*	*	*	5	1	*	1	*	1	3	3
OXIDIZING AGENTS	*	*	*	*	*	*	1	1	*	1	1	*	*	*	*	2	1	*	1	*	1	2	2
INORGANIC SALTS	*	*	*	*	*	*	1	1	*	3	1	*	*	*	*	6	2	*	3	3	3	4	4

GIVING RELATIONSHIP OF VARIOUS GRADES OF LAMINATED MA

Prepared by The Formica Insulation Company

LEGEND: GRADES IMPROVE QUALITATIVELY FROM 1 TO 10. ASTERISK INDICATES VALUES NOT SIGNIFICANT FOR GRADE AND NO DATA AVAILABLE.

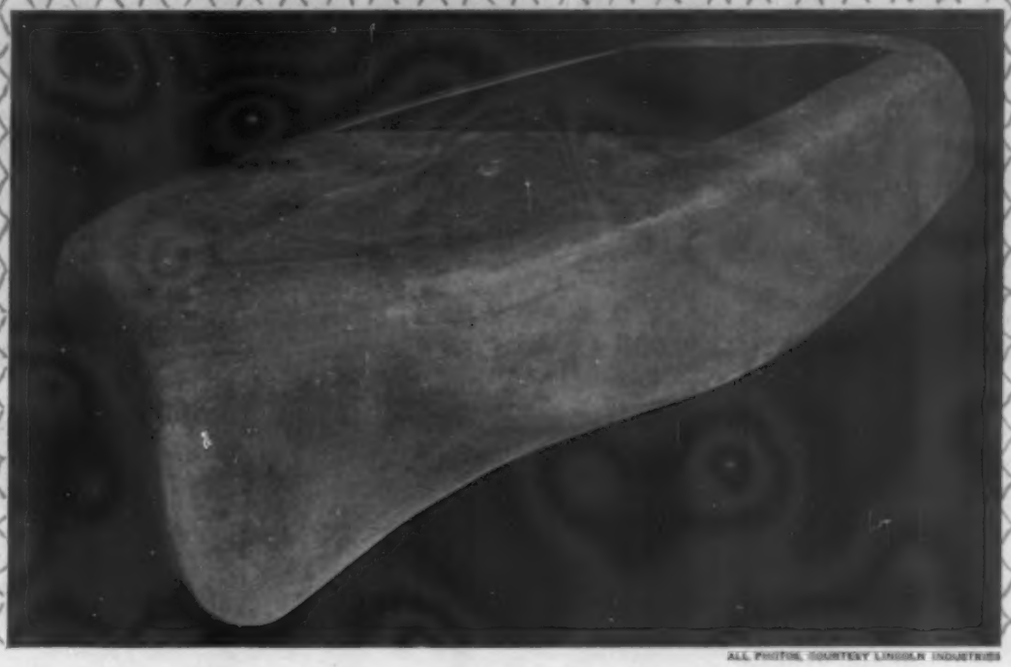
C	CS	CX	CXB-5	CX-7	CX-9	CX-10	CJ-11	CH-32	CXB-38	C E	CHE	CHV	L	LR-5	LR-7	L-9	L-26	LR-91	LB-51	LH	LE	LE-13	LL-19	PBEE MIDD
ASHA									JAN-P-13 LTS-44-B	JAN-P-13 LTS-CH-1			ASHA								ASHA			
ARSE WEAVE	COARSE FABRIC	MEDIUM FABRIC	MEDIUM FABRIC	COARSE FABRIC	MEDIUM FABRIC	MEDIUM FABRIC	COARSE FABRIC	COARSE FABRIC	MEDIUM FABRIC	COARSE FABRIC	MEDIUM FABRIC	MEDIUM FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	FINE FABRIC	EXTRA FINE FABRIC	WOOD VENEER
ENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	MELAMINE	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC
HIGH IMPACT COMBINATION APPLICATION	GEARS	BETTER MACHINING GRADE-C	MOISTURE RESISTANT	PLATING BARREL APPLICATIONS	GRAPHITE BEARING	BEST MACHINING GRADE-C	POST FORMING	MOST CHEMICAL RESISTANT	BETTER MACHINING GRADE-C-	ELECTRICAL APPLICATION REQUIRING TOUGHNESS	BETTER MACHINING GRADE-CE-	MOST MOISTURE RESISTANT GRADE-C	GOOD MACHINING MECHANICAL APPLICATION	MOISTURE RESISTANCE	PLATING BARREL APPLICATION	GRAPHITE BEARING	CLEAN MACHINING	GOOD MACHINING ARC RESISTANT	UNIFORM COLOR WHEN MACHINED	MOST MOISTURE RESISTANT GRADE-L	ELECTRICAL APPLICATION GOOD MACHINING	PAPER MILL DOCTOR BLADES	VERY SMALL DIAM. GEARS	HIGH STRENGTH PROPERTIES
1.36	1.36	1.36	1.36	1.36	1.39	1.36	1.36	1.36	1.36	1.35	1.35	1.32	1.36	1.36	1.36	1.39	1.36	1.50	1.36	1.32	1.35	1.36	1.36	1.38
4	4	4	7	6	4	4	4	8	4	7	7	9	6	7	6	8	6	8	6	9	7	8	8	1
4	4	4	6	5	4	4	4	8	4	6	6	7	5	6	6	5	5	3	5	8	7	7	5	1
1	*	1	1	1	*	1	1	1	1	2	3	*	2	1	1	*	1	10	2	*	4	*	*	1
1	*	2	1	1	*	2	2	1	2	5	5	*	3	1	1	*	1	7	5	*	6	*	*	3
2	*	2	*	*	*	2	3	*	2	6	6	*	2	*	*	*	2	8	6	*	7	*	*	2
1	*	1	*	*	*	1	2	*	1	2	2	*	1	*	*	*	1	3	2	*	3	*	*	2
2	*	2	*	*	*	2	3	*	2	5	5	*	2	*	*	*	5	7	2	*	5	*	*	5
2	*	2	*	*	*	2	1	*	*	1	1	*	2	*	*	*	1	9	2	*	1	*	*	3
1	*	1	*	*	*	1	2	*	1	3	3	*	2	*	*	*	1	8	4	*	4	*	*	*
6	6	5	5	6	6	6	6	1	5	4	4	3	5	4	5	5	5	7	4	3	4	5	4	10
4	4	3	3	4	4	3	5	5	3	3	3	2	3	3	3	3	3	1	3	2	2	3	2	8
8	8	8	8	8	6	8	*	9	8	9	8	8	8	8	8	6	8	10	7	7	9	*	*	6
7	7	8	8	7	8	8	7	8	8	8	8	7	8	8	8	8	9	10	8	9	8	8	8	4
8	*	9	8	7	8	8	9	8	9	8	8	*	10	9	9	9	9	4	8	*	8	9	9	*
10	10	10	10	9	10	10	10	8	10	8	8	8	10	10	10	10	10	8	10	8	9	10	10	8
3	4	3	3	3	3	3	4	3	3	3	3	2	3	3	3	3	4	4	3	3	3	3	3	2
3	3	3	5	4	*	3	3	6	3	4	4	6	4	5	4	*	4	2	3	6	5	4	4	*
1	*	1	3	3	*	1	1	2	*	2	2	4	1	3	3	*	2	10	1	4	3	1	1	*
1	*	1	2	2	*	1	1	3	1	1	1	2	1	2	2	*	1	2	1	2	1	1	1	*
3	3	3	4	4	3	3	3	6	3	4	4	6	4	5	4	3	4	5	3	6	5	4	4	*

PUBLISHED MAY 1946 ISSUE MODERN PLASTICS MAGAZINE

TED MATERIALS

GRADE	LL-19	PBGE MOOD	A	A-3	AA	AA-38	AAA-41	AAA-65	AAA-79	FF-10	FF-27	FF-34	FF-41	FF-55	HF-66
STANDARD SPECIFICATIONS			NEMA		NEMA					JAN-P-13 LTS-66-5				JAN-P-13 (MIL)	JAN-P-13 LTS-66
BASE	EXTRA FINE FABRIC	MOOD VENEER	ASBESTOS PAPER	ASBESTOS PAPER	COARSE ASBESTOS FABRIC	FINE ASBESTOS FABRIC	ASBESTOS MAT	ASBESTOS MAT	ASBESTOS MAT	STAPLE GLASS CLOTH	CONTINUOUS GLASS CLOTH	CONTINUOUS GLASS CLOTH	STAPLE GLASS CLOTH	CONTINUOUS GLASS CLOTH	GLASS MAT
TYPE RESINS	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	PHENOLIC	MELAMINE	PHENOLIC	PHENOLIC	PHENOLIC	MELAMINE	PHENOLIC	MELAMINE	MELAMINE	MELAMINE
MAJOR CHARACTERISTICS:	VERY SMALL GEARS	HIGH STRENGTH PROPERTIES	HEAT RESISTANT FOR LOW VOLTAGE	HEAT RESISTANT FOR TEXTILE APPLICATIONS	DIMENSIONALLY STABLE, MOISTURE RESISTANT	BETTER MACHINING THAN AA	ARC RESISTANT ASBESTOS BASE	DIMENSIONALLY STABLE UNDER HIGH TEMPERATURES	HEAT RESISTANT	HEAT RESISTANT GLASS BASE	THIN ARC & FIRE RESISTANT SHEET	THIN HEAT RESISTANT GLASS BASE SHEET	ARC AND FIRE RESISTANT	HIGH IMPACT ARC & FIRE RESISTANT	LOW ELECTRICAL LOSS
SPECIFIC GRAVITY	1.38	1.38	1.55	1.55	1.58	1.48	1.8	1.8	1.8	1.67	1.95	1.67	1.90	1.95	1.50
PROPERTY															
WATER RESISTANCE	6	1	8	8	7	7	7	8	8	5	7	5	7	7	10
DIMENSIONAL STABILITY	5	1	6	6	7	7	4	5	5	9	8	8	4	8	9
INSULATION RESISTANCE	*	1	1	*	*	*	2	1	1	1	2	1	2	2	8
DIELECTRIC STRENGTH PERPENDICULAR TO LAMINATIONS	*	3	1	*	*	*	1	1	1	3	6	3	4	6	8
DIELECTRIC STRENGTH PARALLEL TO LAMINATIONS	*	2	1	*	*	*	2	2	1	1	4	1	2	4	10
DIELECTRIC LOSSES RADIO FREQUENCY	*	2	*	*	*	*	1	1	1	5	7	6	7	7	10
DIELECTRIC LOSSES POWER FREQUENCY	*	5	*	*	*	*	3	1	1	3	9	5	1	9	10
ARC RESISTANCE	*	3	*	*	*	*	8	1	1	2	10	2	9	10	2
STABILITY OF ELECTRICAL PROPERTIES ADVERSE CONDITIONS	*	*	*	*	*	*	2	1	1	1	5	2	1	5	10
MECHANICAL STRENGTH	4	10	3	3	4	4	9	8	8	9	9	9	8	10	4
IMPACT STRENGTH	2	8	1	1	4	4	6	6	5	9	*	8	9	10	2
BONDING STRENGTH	*	6	2	2	7	7	3	3	3	4	*	*	6	7	3
MACHINABILITY	8	4	4	4	1	3	5	7	2	1	2	1	1	2	5
PUNCHING	9	*	3	*	2	2	6	7	3	3	2	3	2	2	6
WEAR RESISTANCE	10	8	7	7	7	7	7	7	7	1	1	1	1	1	2
HEAT RESISTANCE	3	2	8	9	9	8	7	8	8	10	8	9	7	8	4
CHEMICAL RESISTANCE															
ACIDS	4	*	2	2	4	4	2	4	4	8	2	7	2	2	*
ALKALI	1	*	3	3	5	5	7	3	3	3	4	3	4	4	*
OXIDIZING AGENTS	1	*	1	1	1	1	1	1	1	2	4	2	4	4	*
INORGANIC SALTS	4	*	2	2	4	4	4	4	4	8	5	7	5	5	*

Production of honeycomb cores



ALL PHOTOS, COURTESY LINCOLN INDUSTRIES

Production-line methods of manufacturing honeycomb core material led one company to mold the one-piece hull, shown above, without benefit of interior supports

by J. D. LINCOLN*

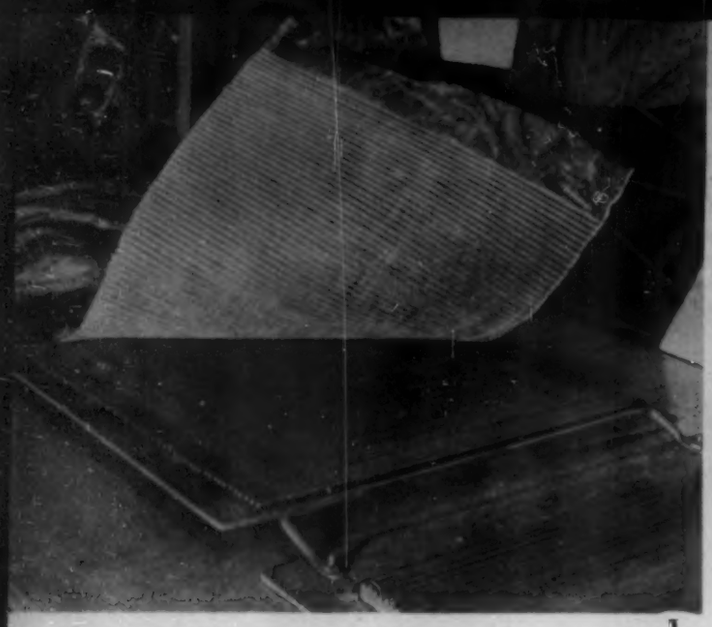
SINCE the inception of low-pressure laminating, development work in this industry has been directed toward the production of stronger sections—ones that could stand by themselves as structural materials—and more efficient methods of production.

How far the industry has come in the past few years is evidenced by the fact that in the first comprehensive description of these materials and their method of processing, published in the September 1942 issue of MODERN PLASTICS, the sole emphasis was on their application to non-structural parts. This article, by Mr. John D. Nelson and G. F. D'Alelio, compared the properties of the products manufactured through the use of low pressure with those resulting from the more common high pressure methods. The entire discussion centered around "skin" laminates made up of varying numbers of layers of fillers. It spoke of non-structural and semi-structural parts of aircraft such as fairings, fillets, housings, cowlings and ducts, and pointed to these parts as being excellent examples of irregular shaped objects which would be extremely difficult, if not impossible, to laminate on high pressures. Further, since the loads these parts were required to carry were not particularly severe, their fabrication by low-pressure methods was considered entirely feasible.

In May of 1944, MODERN PLASTICS again published all-important information on this process—a group of articles giving the first detailed account of the application of low-pressure glass fiber laminates to aircraft. One of these manuscripts, written by Capt. George B. Rheinfrank, Jr., and Lt. Wayne A. Norman, of the Aircraft Laboratory Engineering Division, U. S. Army Air Forces, Wright Field, described an airplane fuselage constructed of glass fiber which had been laminated with a contact resin.

No longer was it necessary that low-pressure molding be restricted to non-structural parts not expected to carry severe loads. As a matter of fact, the fuselage described in this article showed no signs of buckling at 180 percent of design load, whereas its counterpart in metal buckled severely at 100 percent. While glass cloth and resin had a great deal to do with the increased strength of this low-pressure molded part, the most important factor was perhaps the new method of construction. Instead of comprising only several layers of filler material, this airplane fuselage was made of a sandwich structure incorporating a balsa wood core

* Lincoln Industries.



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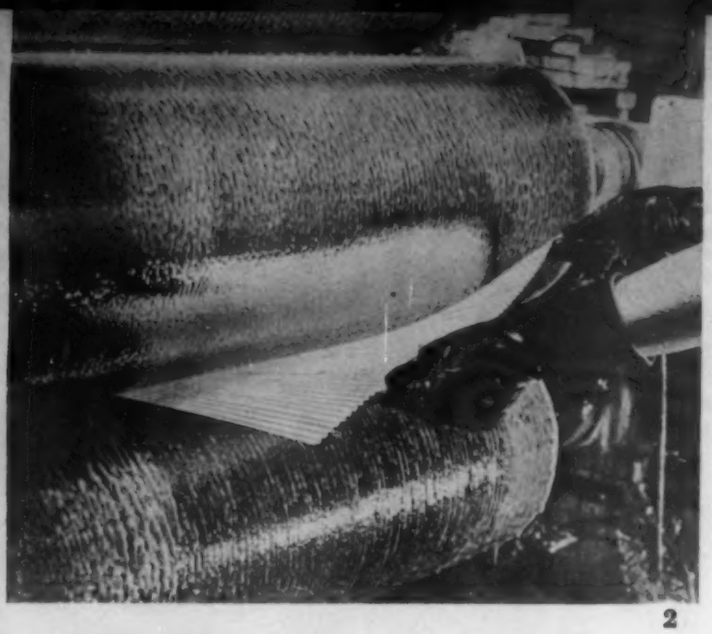


2

1—A sheet of glass fiber cloth, molded into the corrugated pattern needed for honeycomb structure, is stripped from the mold. 2—Before a layup is made, high spots of the corrugated sheet are coated with an unsaturated polyester resin. Special doctor rolls which are separated by about 3/16 in. perform this work

set between thin inner and outer skins of glass-reinforced laminate.

Since that time, many different types of sandwiches have been produced with skins of paper, glass fiber, duck, steel and aluminum; with cores of various expanded thermoplastics laid up between the two skins.

All methods for producing cores and for bonding them to the different skins have been used to turn out boats, droppable gas tanks and, above all else, radomes. As our radar equipment was increased in efficiency and range, the low-pressure industry was under the necessity of keeping step with these developments and producing radomes with better electrical properties.

Honeycomb cores

To meet the ever-increasing demands of the Army and Navy laboratories, a new and different type of core was developed. Known as a honeycomb core, inasmuch as its appearance is very like that of the well-known comb in which bees produce their honey, it is composed of sheets of glass fiber cloth, formed into a corrugated pattern, laid up in such a manner as to produce the cellular structure required. There was, however, one large problem as far as this material was concerned—how could it be produced with any semblance of economy. For many months, production was on a laboratory scale only.

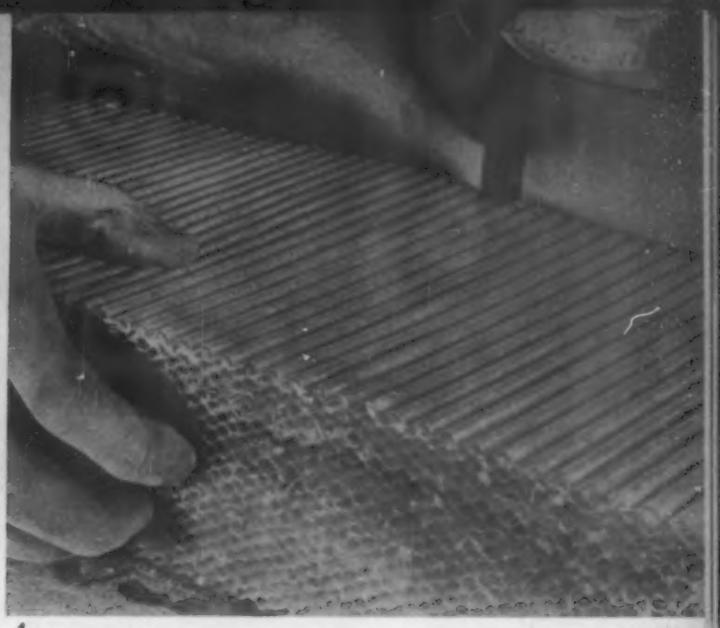
The Lincoln Industries, formerly the Virginia Lincoln Company, have been in fairly large-scale production on honeycomb for some time. While we do not claim to have developed the production method described in the balance of this article, we have added a few refinements which make our production of this material most satisfactory.

The first step in the present production method is to impregnate the glass fiber cloth with a contact resin, in this case Plaskon 911-11. To keep the weight of the finished honeycomb at a minimum, this 0.003 in.-thick glass fiber cloth is impregnated with 20 percent of resin by weight, a percentage which is maintained through the use of a special set of doctor rolls comprising two metal and two rubber-covered rolls. The viscous resin is fed between the two metal rolls, one of which is in contact with one of the rubber-covered rolls which is about twice the diameter of the metal rolls. By adjusting the spacing between one of the metal rolls and the rubber impregnating roll adjacent to it, the resin pick-up of both impregnating rolls can be accurately controlled. The second large rubber roll is placed so that it contacts the first rubber roll. With this system, the resin is fed to the steel rolls, transferred to the first large diameter rubber roll, then to the second rubber roll—the two large rolls acting as impregnating or coating rolls and the material being passed between them.

After a quantity of glass fiber cloth has been impregnated with an accurate amount of resin, it is cut into sheets measuring 18 by 19 inches. One of these sheets is then placed on a plate machined in the form of a grid. To produce the top half of this mold, which is made up of a series of round rods, the following process was employed. Each rod has a hole drilled in both ends horizontal to its axis. A flexible wire is passed through these holes and through spacers which separate the rods a distance equal to that which divides the grids comprising the lower plate. This rod layup is placed on top of the layer of impregnated glass cloth which is already resting on the bottom grid. A heavy roller is then passed back and forth over this upper rod assembly, forcing each rod into the valleys between the grids in the lower plate. This, of course, causes the glass cloth to take on the contours of the grid. A flat steel plate is then placed on top of the rods and the assembly placed between platens of a hydraulic press.

With a temperature commensurate with a steam pressure of 100 p.s.i. in the platens of the press, a cure time of about 1½ min. is satisfactory to set up the

3



4

3—After coating, location holes are pierced in corrugated sheet. Impregnated material is slipped over pins, which accurately position each sheet in relation to its neighbor, and stacked to required thickness. 4—After honeycomb is cured, it is cut to required thickness. A standard band saw is satisfactory for this work

resin in the corrugated glass fiber cloth. This cure is effected with very low pressure, on the order of 50 p.s.i. The molding operation is on a semi-continuous basis inasmuch as two sets of molds are used. After curing, the mold halves are separated and the corrugated glass cloth is stripped from the mold by hand (Fig. 1).

Making the layup

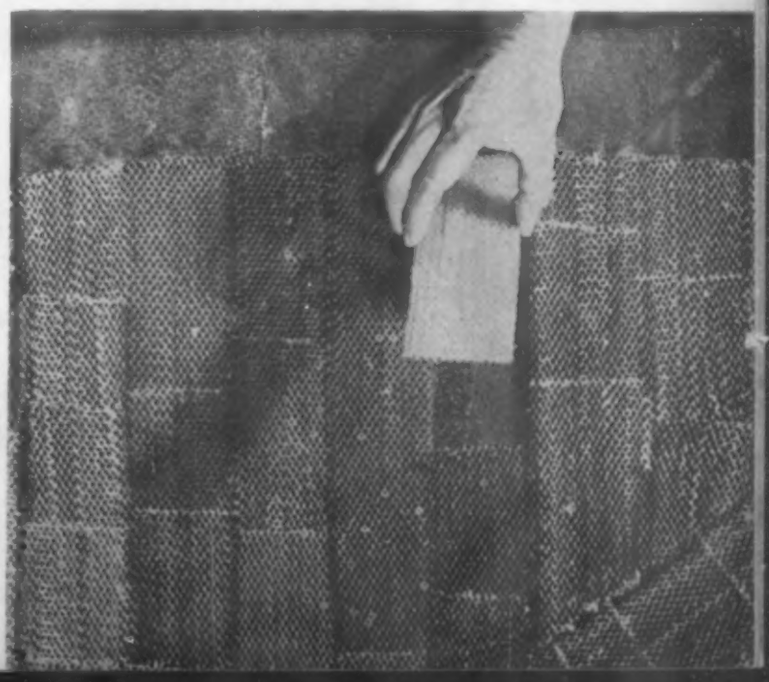
The sheets are then trimmed to size with a foot-operated guillotine knife and laid up in a stack, location holes being jig drilled along two sides of each sheet. These holes are used to accurately position each sheet with relation to those adjacent to it in the final layup. The high points of each of these gridded sheets must then be coated with adhesive. The same set of doctor rolls used for impregnating the cloth are used in this operation. However, in this case, the two rubber applying rolls are separated approximately $^{3}/_{16}$ in. so as not to crush the shaped material. One operator feeds a sheet of the gridded material through the two applying rolls, while a second operator guides the coated sheet as it comes out (Fig. 2).

Figure 3 shows the manner of laying up a stack of honeycomb. The location holes in the side of the sheet are spaced so that they match accurately with the pointed pins holding the stack in position. By this method, the cores of the honeycomb are held uniform while the bonding agent is setting up. After the stack of honeycomb is cured in an oven, it is easily removed from the locating pins and is ready to be sawed to whatever thickness is required for the job in hand. Figure 4 shows the operator sawing a $^{5}/_{16}$ in. section of honeycomb for use in one of the latest type radomes. A standard band saw is satisfactory for the operation.

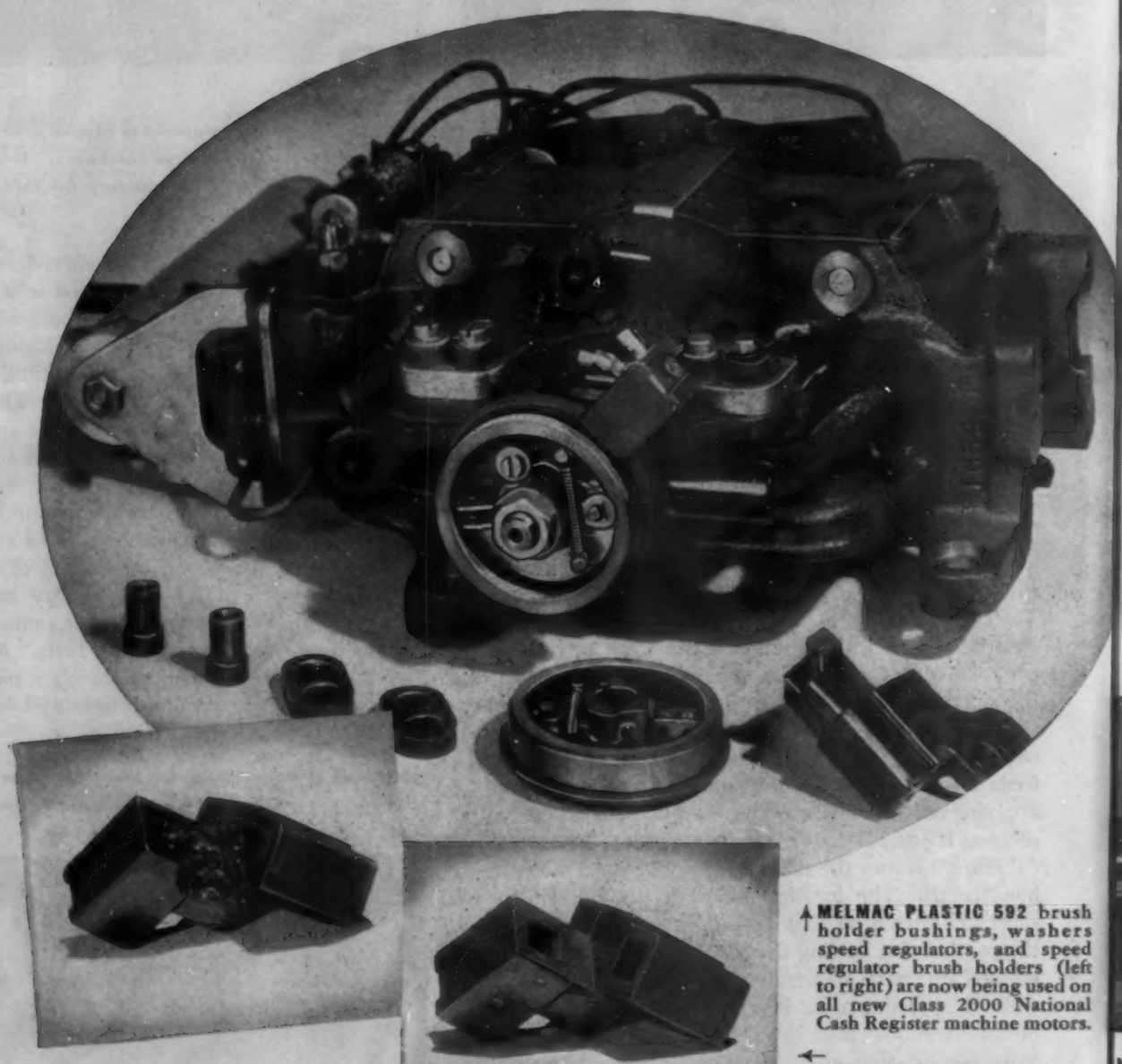
It is quite obvious that these sections of honeycomb would not be satisfactory were they to be used for anything but an absolutely flat layup. Inasmuch as they have been cured, they are fairly rigid and do not lend themselves to the contours of a curved form. However, should these sections be dipped in a solution of Plaskon 911–11 which has been thinned with acetone, they would again become flexible and hold this flexibility for several hours. In this condition, the honeycomb will form itself to reasonable curvatures with a minimum of effort. Figure 5 shows the operator laying up the final section of honeycomb in a radome.

It is not necessary that honeycomb be produced from glass fiber cloth and, of course, it is not necessary that it be produced in this manner. As I stated at the Low Pressure Conference of the Society of Plastics Industry in Chicago, a honeycomb may be produced very simply and very cheaply in the same manner as the grids of honeycomb Christmas bells. As a matter of fact, our company is now producing a paper honeycomb by this method at an unbelievably low price.

5—Sections of honeycomb are laid up as core in a sandwich type radome about 4 ft. in diameter and 4 ft. high



Melmac Plastic...



MELMAC PLASTIC 592 brush holder bushings, washers speed regulators, and speed regulator brush holders (left to right) are now being used on all new Class 2000 National Cash Register machine motors.

COMPLETE BREAKDOWN of general-purpose plastic materials (left), originally used for rotating insulating parts occurred when carbon dust and oil used for lubrication combined and ignited from brush sparking. With MELMAC 592, contamination burns off, leaving an excellent insulating surface.

Cyanamid Plastics

BEETLE · MELMAC · MELURAC · LAMINAC · URAC

INSULATION REDUCES MAINTENANCE ON NATIONAL CASH REGISTER MACHINES

Costly repairs and involved service charges for replacements are being eliminated by the installation of MELMAC* plastic 592 insulation parts in the motors of National Cash Register machines. Rigorous tests show that MELMAC parts operate more dependably than those made of the general-purpose plastic formerly used because of MELMAC's high arc resistance and excellent insulating properties.

Comparative tests of the two materials in rotating parts such as speed regulators and speed regulator brush holders were made under actual working conditions on Class 2000 motors.

During track resistance tests, a mixture of oil and carbon dust was smeared on the insulating parts. When the carbon brushes in the brush holders contacted speed regulators, this contamination caused arcing. The material formerly used showed an immediate track and eventually burned through. With MELMAC, contamination burned off, leaving an excellent insulating surface. Brush holders of the former material burned out and had to be replaced at 24, 35, 106, 250, 335 and 1173 hour intervals. Speed regulator insulators had to be replaced at 250 and 772 hours. All MELMAC parts were still functioning as insulators at the termination of 1423 hours.

MELMAC 592 bushings and washers are also being used on all new Class 2000 motors and as replacements for breakdowns in the field.

If such exceptional arc resistance and dielectric strength in an insulating material are important to you, let us give you complete details on our mineral-filled MELMAC plastic 592.

*Reg. U. S. Pat. Off.

AMERICAN CYANAMID COMPANY
Plastics Division
32 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

MELMAC PLASTIC, used for brush holder bushings, washers, speed regulators, and speed regulator brush holders, prevents failure of the insulating parts in the motors on these machines. These same motors are used on many other types of calculating and cash register machines made by National Cash Register Company.

WATERPROOF BOXES made with URAC* resin and starch, used so extensively by the armed forces for severe shipping and weather conditions, are now in wide use for postwar shipment of perishable goods such as seafood, meat, fruits, vegetables, or other products which contain moisture or are exposed to conditions of humidity or condensation.

CELLULOSE ESTER PLASTIC SHEETING

produced by nonsolvent continuous extrusion

Using a standard extruder and specially developed equipment, cellulose ester plastic may now be produced in continuous sheet form in widths up to 24 inches

FOR many years cellulose acetate sheeting has been produced by three methods which, due to their complexity, have caused the price of sheeting to be high when compared with the price of the raw material from which it is produced. These methods are: 1) block pressing, planing and polishing; 2) casting on a belt; and 3) casting on a wheel.

Of these, the first is the most commonly used method—the flake material being first mixed with a solvent and then cast in cake form. Pressure and heat are employed in the production of this cake. When the material is completely set, it is reduced to sheets of the required thickness by a planer, similar to a veneer-wood planer. In this sheeting operation, longitudinal lines—termed "knife" or "sheeter lines"—are left on the surface of the material. If a high luster and smooth surface are to be achieved, each sheet of material must be placed between highly polished plates which, in turn, are placed in a hydraulic press. A heat and chill cycle under pressure flows the surface of these sheets to conform exactly to that of the polished metal plate, and thereby removes the unsightly knife lines.

The Tennessee Eastman Corp. has recently released details of a new method for producing sheeting in one straight-line operation using a standard extruder and several sets of rolls. The material, Tenite, is extruded continuously in sheet form in thicknesses of from 0.010 to 0.050 in. and in widths up to 24 in. from a circular die operating in conjunction with a conventional plastics extrusion machine. The sheeting is drawn from the die as a tube, slit at the bottom, and subsequently flattened out in one uninterrupted operation. The process, described and illustrated in this article, employs a $3^1/_4$-in. extruder and a $9^1/_2$-in. diameter circular die. The temperatures are for Tenite II, H_2 flow.

As in the extrusion of any cellulose esters section, successful production of sheeting begins with the proper preparation of the pellets. If the pellets contain too much moisture as they are fed to the extruder, the sheet will exhibit small bubbles and the flow from the orifice will tend to surge. There will also be surging if the temperature of the pellets is not uniform from one hopperful to the next.

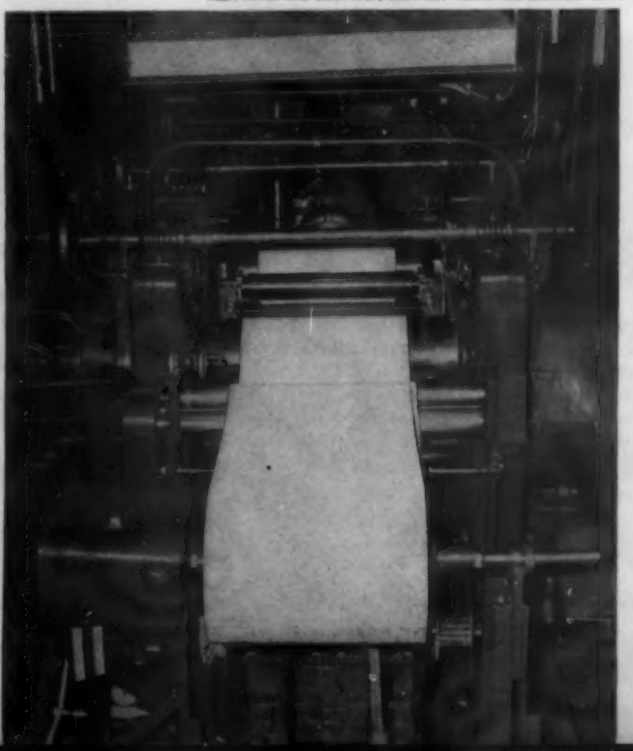
While a satisfactorily low moisture content can be attained by drying the pellets in shallow pans under infrared lamps for 30 min., care being taken to stir the material from time to time, the temperature variation from batch to batch is too great. Best results have been obtained both in respect to low moisture content and temperature uniformity by storing entire drums of pellets (with lids loosened) for 3 days in a room maintained at 125 to 135° F. Drums are removed one at a time from this room and fed directly into the hopper.

Temperature and operation of the extruder

The extruder used in this sheeting process is a standard machine equipped with a variable-speed drive. The jacket around the cylinder is divided into three sections: 1) a water-cooled chamber around the feed throat, 2) an intermediate heating zone, 3) a high-temperature zone at the discharge end. The two

1—In this view of the extrusion and rolling equipment used for the continuous sheeting of cellulose ester plastic, the extrusion head can be seen in the background

ALL PHOTOS AND DRAWINGS, COURTESY TENNESSEE EASTMAN CORP.



latter sections are heated by the circulation of hot oil. While two oil circulation systems are maintained to effect the different temperatures, a single system can be used through the restriction of the flow of oil through the section where the lower temperature is required.

The screw itself is not positively heated or cooled, but becomes hot by conduction from the plastic (which is heated by the cylinder) and from the heat of friction created by the mechanical mixing of the plastic. The water circulating around the feed section is at a temperature of 80 to 90° F. The intermediate section is at 300 to 350° F. The high-temperature zone is at 350 to 400° F. The screw is operated at speeds varying from 40 to 75 r.p.m., depending on the thickness of sheeting that is being produced. Thus, the thinner the sheeting, the fewer the pounds of material extruded per hour, the slower the screw speed.

As the plastic leaves the cylinder, it is forced through a wire screen to remove any large foreign particles and to improve homogeneity. This screen and its supporting baffle plate also tend to minimize surges from the screw. The wire screen is a filter weave—20 × 150 mesh—and is backed up by an 18-mesh screen. This 18-mesh screen rests, in turn, on a baffle plate which has $^1/_8$-in. holes through which the plastic flows.

After passing this screen, the plastic material enters the extrusion die itself. This die consists of a cylindrical shell, inside of which there is a torpedo with a cone-shaped end. The means by which this torpedo is supported deserves particular mention. When only thick sheets (0.020 in. to 0.040 in.) are to be extruded, the torpedo can be held in place by eight webs evenly spaced around its circumference. However, when thinner sheets are made (0.010 in. to 0.015 in.) the pressure on the torpedo is much greater due to the smaller opening at the orifice. It is then preferable to support the torpedo within the shell by a plate through which holes $^5/_{16}$ in. in diameter have been drilled.

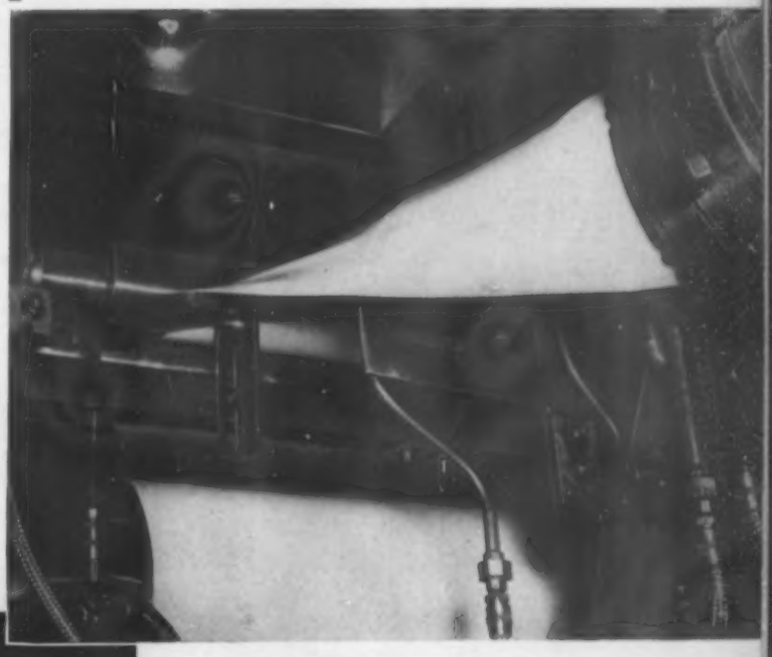
At the discharge end of the die, two rings of hardened and polished stainless steel are inserted which act to form the sheet into its final thickness. The position of the outside ring in relation to the inner ring may be adjusted by means of cap screws to obtain uniform thickness of the extruded tubular section. The diameter of the inside ring is $9^1/_2$ in. and the opening between the rings is determined by the thickness of sheeting to be made. These rings have no radius at their outer edges, but are finished off square and honed just enough to remove the burrs.

The outside shell of the die is heated by a 6000- and a 1950-watt jacket heater, operated in parallel, and controlled by one Wheelco Capacitrol instrument. The torpedo is heated by an 850-watt cartridge heater and controlled by the same type of instrument. Both the shell and the torpedo of the die are maintained at a temperature of from 350 to 400° F.

From tube to sheet

The plastic flows around the torpedo and out through the opening between the die rings. The tube thus

2



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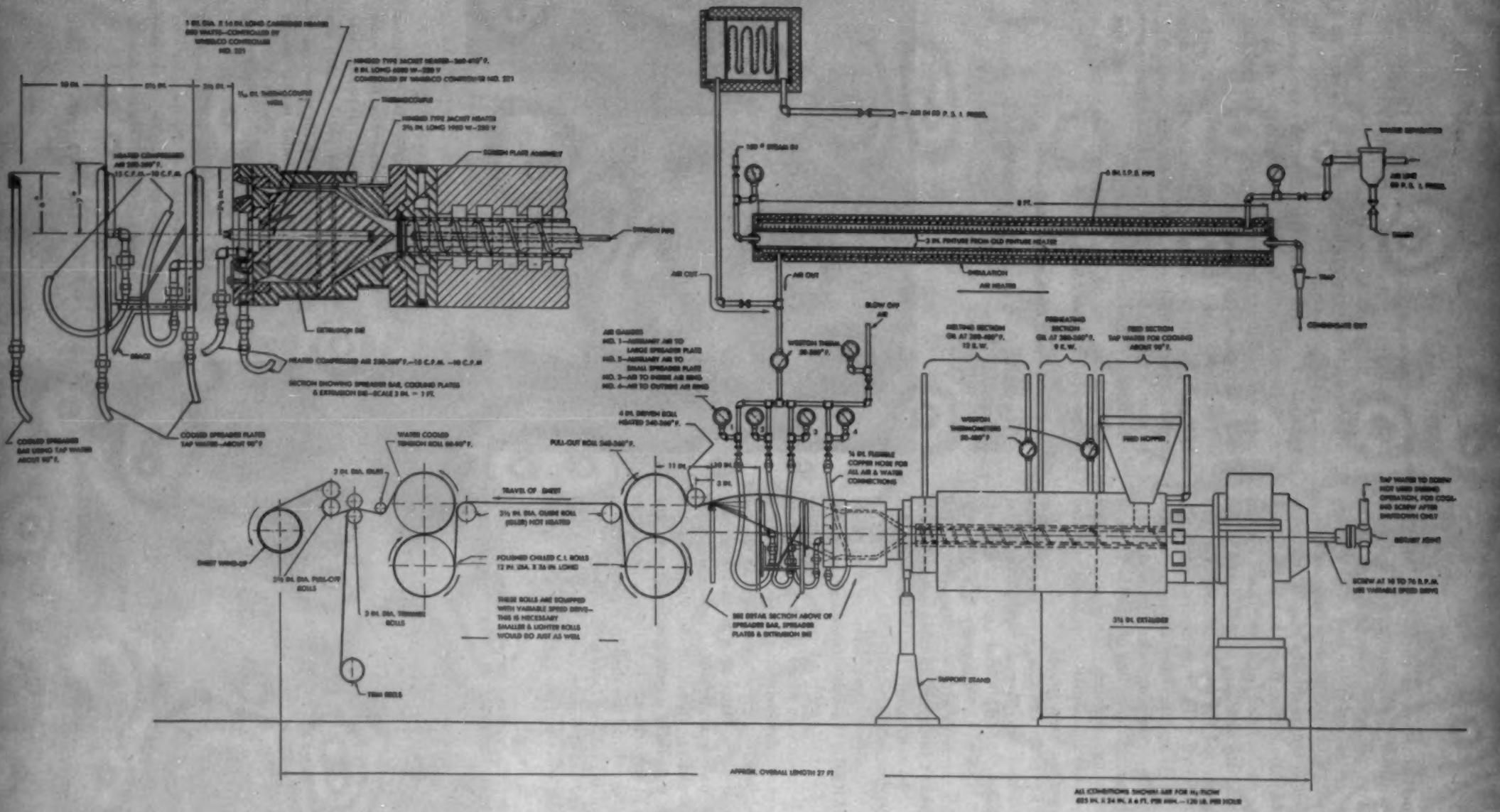
2—Immediately after the extruded cellulose ester tube has been split along its underside, it passes over two brass spreader plates which are formed to support the sheet as it changes from tubular to flat shape

3—The construction mounting and general location of the spreader bars with relation to nozzle of extruder head are clearly evident in this close-up


TRAVEL OF SHEET
SHEET WIND-UP
TRIM KNIVES
SCREW AT 10 TO 70 R.P.M. USE VARIABLE SPEED DRIVE
SUPPORT STAND
APPROX. OVERALL LENGTH 27 FT

4—Diagram of equipment used to produce 24-in. wide sheeting

Table I—Machinery Changes for Varying Thickness of Sheet

Thickness of sheet	*Orifice opening*	*Length of land*
in.	*in.*	*in.*
0.020	0.022	3/8
0.025	0.028	3/8
0.030	0.035	3/8
0.035	0.040	3/8
0.040	0.045	3/4

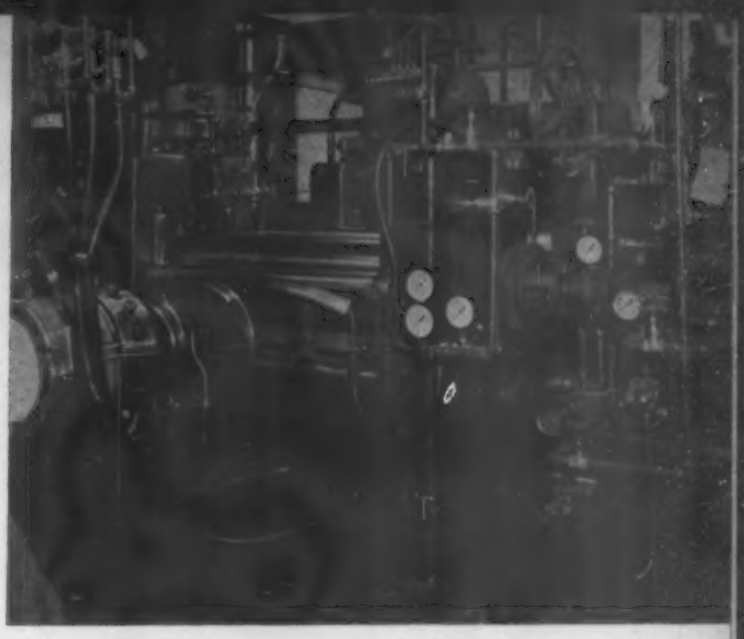
formed is split as it issues from the die by a small brass wedge held in place against the orifice by a bracket fastened to the outside of the die at the bottom. The ends of this wedge are hollow-ground to relieve them enough so that the hot plastic will not hang or drag.

About 1/2 in. from the face of the die rings, air is blown on this split tube from both the inside and the outside. The air issues from a slot in the air rings, which are bolted to the front of the extrusion die. This air, whose flow is regulated by hand valves, is heated by an electrical air heater to about 250 to 350° F. (higher temperatures are for the thinner sections). About 6 to 12 cu. ft. per min. of air are used from an 80-lb. compressed air line. The air acts to set the plastic sheet just enough to make it self-supporting so that it can be controlled in subsequent operations. If cooled too much, the sheet is rigid and hard to flatten. The heating of the air obviates condensation of the fumes and resultant spattering of plasticizer. It also prevents any chilling of the die which would slow or stop extrusion.

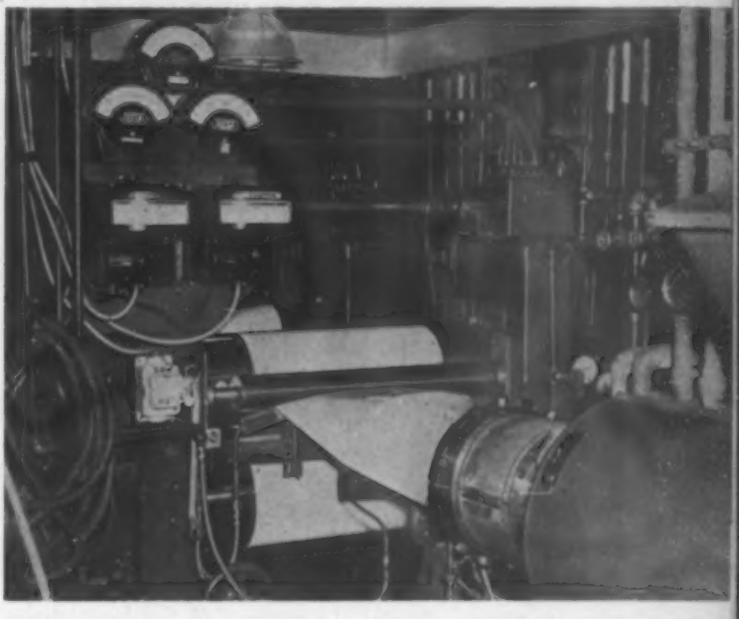
The sheet next passes over two brass spreader plates, formed to support the sheet as it is changing from a tubular to a flat shape. The edges are beveled so the sheet will not drag. The plates are cooled, by water circulated through a pipe brazed onto each, to prevent sticking and chattering of the hot sheet. The first or smaller of these devices is placed 3 to 5 in. from the face of the die; the second or larger spreader plate is 11 to 14 in. from the face. From these plates the partially cooled sheet passes over a curved spreader bar which is constructed like the previously described plates but has a much larger radius. This bar is placed 20 to 24 in. from the face of the die, and after passing this point the sheet lacks little of being flat.

From the spreader bar the sheet passes under a 4-in. diameter heated and driven roll to effect final flattening. Thence it travels in an "S" shape around a pair of 12-in. diameter pull-out rolls. The latter are maintained at from 230 to 250° F. and operated by a variable-speed drive. These rolls are highly polished so as not to mark the sheet and apply no pressure or calendering action. Their sole purpose is to draw the sheet from the orifice.

The plastic sheet next passes to a second pair of rolls called tension rolls. These serve to hold the sheet taut while it is cooling in the space between the two pairs of rolls, which approximates 4 feet. The tension rolls are maintained at 75 to 85° F. by the circulation of



5—This view of the extruder of the cellulose ester sheeting shows the two sets of take-off rolls and the position of spreader bars in relation to extrusion head



6—After the extruded sheeting passes the spreader bar it goes beneath a 4-in. heated and driven roll which effects a final flattening of the cellulose ester sheet

water, and have variable-speed drives. They complete the cooling of the sheet which travels around them in an "S" shape.

Finally, the flattened and cooled sheeting is conducted through cutters which trim it to a uniform width. It is then wound on a reel or cut into convenient lengths on a table.

Actual experience in extruding by this method has shown that lands of varying widths and orifice openings of different relative sizes are required on the die rings for different thicknesses of sheeting. Changing from one thickness of sheeting to another is accomplished by replacing the inside die ring. The data in Table I

shows the length of lands and the different orifice openings required for several thicknesses of sheeting: The capacity of the 3½-in. extruder varies from 90 to 125 lb. per hr., depending on the thickness of the sheeting being made. Likewise, the rate of travel of the sheet varies—from 4 to 9 ft. per minute.

Equipment used for polished sheeting

To obtain an even higher luster than that already produced on the sheeting, equipment and methods described in succeeding paragraphs may be used. After the sheet passes over the water-cooled spreader bar, it enters the bite of the first of a series of rolls which perform a polishing operation. The machine employed for continuously polishing Tenite sheeting consists principally of a large drum with five smaller rolls evenly spaced about the lower half of its periphery and set as close together as their bearing supports will permit.

The large drum is 24 in. in diameter and 18 in. long, supported by shafts about 4 in. in diameter, turning in roller bearings. It is driven by a variable-speed direct-current motor through a gear reducer, and a Weston tachometer indicates the speed at which it turns. The drum is hollow (its shell is about ½ in. thick) and it is equipped with a rotary union at one end of the shaft so that it may either be heated with 90-lb. steam or by circulating hot oil or hot water. Due to the volume of the drum, oil heating is slow; steam or water is preferable as a heating medium. The surface of this drum is of highly polished chromium plate.

The five smaller rolls, spaced around the lower half of the periphery of the big drum, are about 6½ in. in diameter and 18 in. long. They, like the large roll, are fitted for heating with either oil, water or steam. These rolls are not driven; they are rotated by contact with the sheet as it travels with the large drum. Each of these rolls is chromium-plated and each has a polished surface equal to that of the large drum.

These small rolls are supported at each end by bearings which are adjustable in and out—i.e., the rolls may be moved toward the surface of the large drum or away from it. Adjustable stops at the inside end of the bearing brackets can be set to stop the roll at any clearance between it and the face of the drum.

The sliding bearings are spring-loaded so that the rolls can move in and out with variations in the thickness of the sheeting so as to prevent fracturing. The springs employed are fairly stiff, requiring about 600 lb. per quarter-inch of deflection. The shells of the large drum and all the small rolls must be of a steel that can be hardened prior to grinding and plating.

The operation of this polishing machine is based on the principle that the sheet will stick to and lie flat on the surface that is maintained at the higher temperature—in this case the large drum. While thus supported, the sheet is soft enough to be ironed out by the hot rolls, receiving a polish on both sides at once.

The temperatures indicated below and the other details apply to Tenite I sheeting, H_2 flow, 0.020 in. thick.

The *when* and *how* of polishing

The hot plastic sheet, which has been flattened from a tube to a sheet in passing over the water-cooled spreader bar set just beyond the extruder head, is fed down between the first small roll and the large rotating polishing drum. The clearance between the surfaces has previously been set at 0.006 inch. The springs are pulled down almost completely. The temperature of the small roll as measured with a surface pyrometer is 240° F.; that of the large drum is 265° F. The chief function of this first roll is to lay the sheet very flat against the large drum and to iron out any air or gas pockets which might be entrapped under the hot plastic.

The sheet, which adheres to the large drum, travels with it and is next carried past the second and third small rolls, which are both set for a clearance of 0.006 in. and are heated to a surface temperature of 265° F. The springs on both of these rolls, which do most of the polishing on the sheet, are also at almost full tension:

The plastic sheet then passes the fourth and fifth rolls, which are maintained at 70° F. They are set for 0.008 in. clearance and are lightly spring-loaded. One air pipe is placed lengthwise between them, and another is similarly placed just after the fifth and last roll. Air at room temperature is directed against the sheet to aid in its cooling. The cold rolls and air combine to harden the sheet enough so it can be removed from the drum without sticking or stretching.

Following the stripping of the material from the drum, the sheet is conducted through the bite of a pair of rubber rolls which are driven through a slip clutch at a speed just fast enough to keep some tension on the material. This operation is necessary to keep the sheet stripping from the drum without chattering and also to prevent its distortion. The rolls are rubber-covered so that the surface of the polished sheet will not be scratched. From these last rolls, the sheet may either be wound up directly or conducted along a belt conveyor to a cutting table.

As noted above, temperature control is extremely important. For this reason, dial thermometers are placed in the outlet lines of each roll end of the drum to indicate the line temperatures. The machine is actually operated by the surface temperatures as determined by the contact pyrometer.

Cleanliness is also important. The surface of the chromium plate is kept clean by being wiped with soft dry cloths from time to time and through the use of a suitable chrome polish when necessary. Since any hard foreign particles in the air which might fall onto the polished surfaces will create imperfections, the air in the operating area should be filtered or the equipment separated entirely from other operations.

A service to the industry

The Tennessee Eastman Corp. does not intend using this equipment for the production and sale of sheet materials. This development work has been done as a service to the plastics industry.

Transparent Tenite plastic forms the half-pint barrel of this oiler and sprayer molded by Columbus Plastic Products, Inc., for Midwest Production Machine Company

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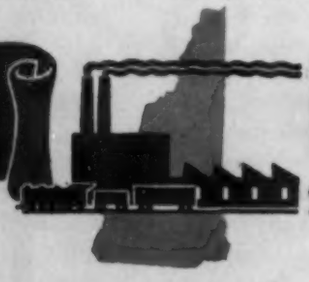

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High pressure polymerization of ethylene*,†

POLYETHYLENES have a number of properties which deserve highest consideration. Apart from remarkable dielectric qualities which make it possible to use them extensively in the cable industry, their resistance to acids, alkalies and solvents and their good compatibility with polyisobutylene are outstanding. Moreover, ethylene is the cheapest compound which can be polymerized and, in normal times, is available in practically unlimited quantities.

The properties of the polyethylenes depend largely on the degree of polymerization. The products of low molecular weight are first-grade lubricating oils (SS-oils); the medium molecular weight products are hard waxlike substances; the products of high molecular weight are white paraffinlike compounds which can be processed into elastic films having a high folding endurance.

We are indebted to Imperial Chemical Industries, Ltd., for the discovery of the solid polyethylenes. Thus far, they have developed the types that are listed in Table I.

Our own investigations were aimed first at reproducing the products of I.C.I. Since their patents do not contain any statements about the machinery used, it was necessary to develop equipment from the very beginning. It was clear to us that a continuous process was needed since only a relatively small part of the ethylene polymerizes and, consequently, the bulk of the gas, must be recirculated.

We endeavored to develop processes independent of those of I.C.I. The fact that the foreign patent rights were all founded on the use of pressures over 500 atmospheres, served to indicate the direction of our investigations. Indeed, we succeeded in polymerizing ethylene in the presence of organic solvents to solid products. The 10 tons/mo. pilot plant constructed in Zweckel as a consequence of these investigations has been running for almost two years. Its product is a waxlike substance of low molecular weight which is marketed under the name of I. G. Wax A by the Dye Division and under the name of Lupolen N by the Plastics Division.

I. G. Wax A (Lupolen N)

Degree of purity of ethylene—The first batch of experiments in autoclaves with ethylene containing some acetylene showed that small impurities in the acetylene decreased the yield. During the further development of the process, especially with the opening of the continuous plant producing 10 tons/mo., it was found that small quantities of acetylene, 0.1 to 0.3 percent, have no appreciable influence on the polymerization.

The various ethylenes obtained from natural gas in Holten and Zweckel, from the Saar district in Oppau, and the acetylene-free hydrogenation ethylene from Schkopau gave practically the same yield. The average composition of the gases is as follows:

	Percent
Ethylene	98
Ethane	1 to 2
Nitrogen	0.5 to 1.0
Acetylene	0.1 to 0.3

Experiments at 200 atmospheres—The process is as follows: a paste of methanol and benzoyl peroxide is pumped into a solution of ethylene in methanol at 200 to 300 atmospheres and the mixture is reacted at 110 to 120° C. in a coil reactor. After the reaction, most of the polyethylene is obtained as a precipitate. The part of the ethylene which did not react is freed from aldehydes in a caustic soda bath and recirculated. Methanol is returned to the system after distillation.

During further investigation of this process, it became evident that pumping of a concentrated benzoyl peroxide paste into the ethylene-methanol solution was not feasible for a permanent installation. Apart from the danger involved, finely crystalline paste deteriorated the valves of the pumps in a very short time.

Likewise, pressure boosters wherein the pistons have to work, by means of a small Bosch pump, with methanol against a pressure of 200 atmospheres, are not suitable for handling the catalyst paste. A large part of the catalyst crystals precipitated after a short time in compressors and prevented a uniform feed of paste.

Now, the catalyst is finely dispersed in the necessary methanol and this dispersion is fed to the suction side of the methanol pump by means of a centrifugal pump—

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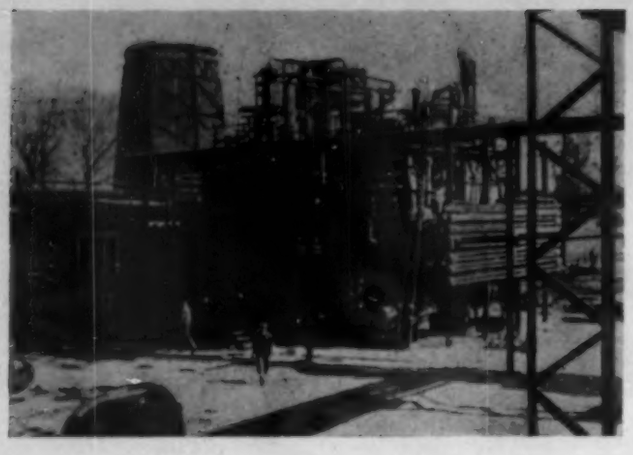
* A report presented at the 26th Kuko (Plastics Committee) meeting in Ludwigshafen on Feb. 15, 1943, by Dr. Hopff and Dr. Goebel, I. G. Farbenindustrie A.-G. This translation was prepared by Mrs. I. G. Callomon and Dr. G. M. Kline, National Bureau of Standards.

The Department of Commerce is merely distributing this technical information which has come into its hands from captured German territory. This information should be made available to all United States citizens interested in it, but use of it by anyone must be and is at one's own risk in so far as the United States or foreign patent violations are concerned.

† Further details regarding the experimental polyethylene plant in Ludwigshafen and the 5 tons/mo. plant, which was under construction in Gendorf in May 1945, will be found in the Office of Publication Board Report 949, entitled "Investigation of German plastics plants," by G. M. Kline, Ordnance Dept.; J. H. Rooney, J. W. Crawford and T. Love, British Ministry of Supply; and F. J. Curtis, Chemical Warfare Service.



1—The Zweckel plant for the production of I. G. Wax A

the methanol pump compressing the dispersion without difficulty to 200 atmospheres. In this way an even distribution of the catalyst mass into the polymerization system is achieved and, at the same time, the life of the valves is decidedly prolonged.

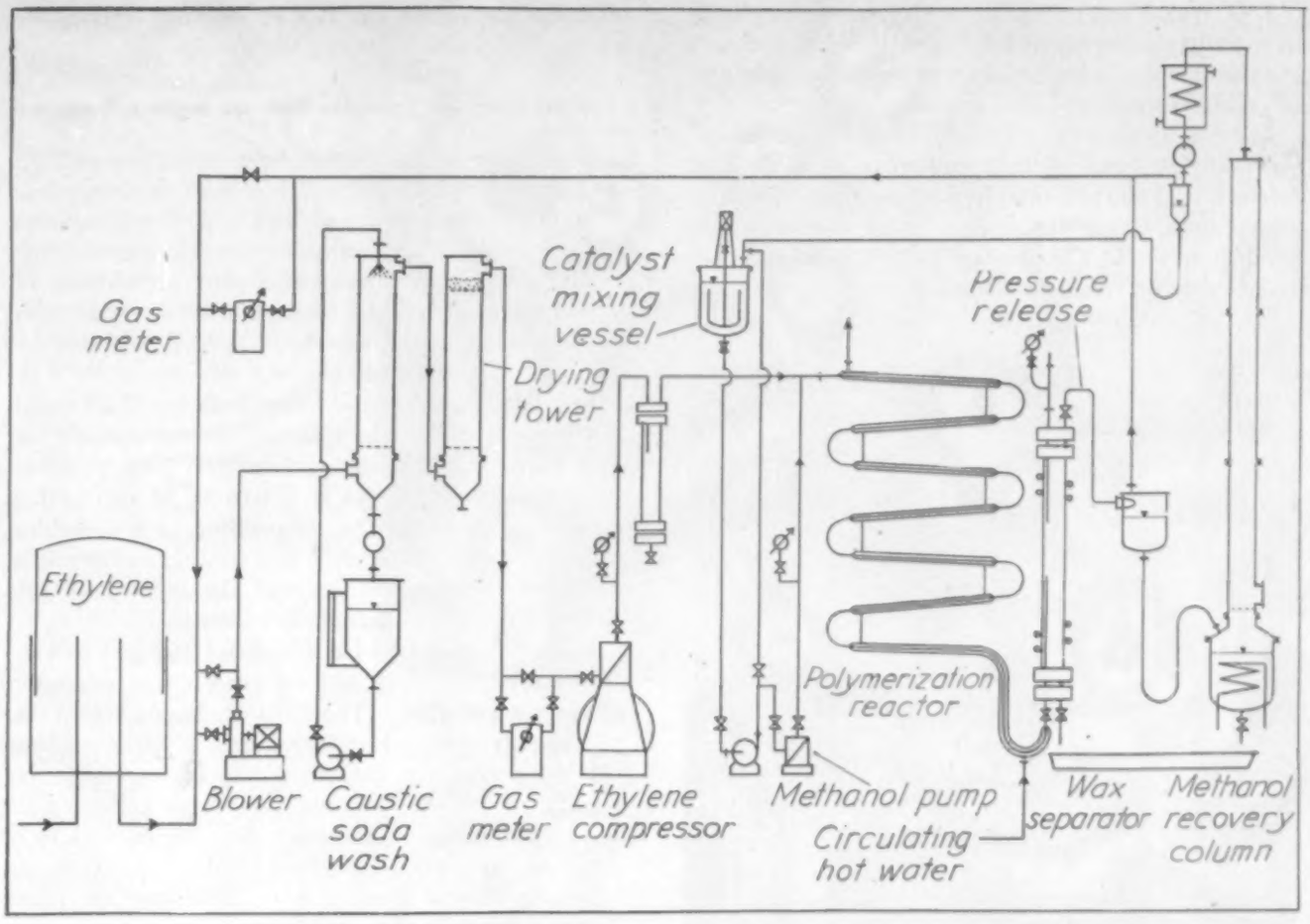
Zweckel plant for producing I. G. Wax A (Fig. 1)—The plant operates according to the flow diagram shown in Fig. 2. Ethylene is taken from a gas meter by means of a blower through a bath of caustic soda and a drying tower to a compressor. This compresses the gas into a buffer tank at 200 atmospheres. Simultaneously, a 1 percent dispersion of benzoyl peroxide in methanol is fed by means of a centrifugal pump from the catalyst mixing vessel to the suction side of a high pressure pump. The dispersion is brought by this pump to 200 atmospheres pressure and together with the compressed ethylene enters the polymerization system through a mixing jet.

Circulating hot water heats the polymerization system to 115 to 120° C. and serves at the same time as a good heat exchanger (1000 kcal./kg. wax are released). The heating system works on the countercurrent principle. By running the polymerization tube into the lower third portion of the vertical separator, a good separation of the wax from the ethylene-methanol mixture, which is of lower specific gravity, is accomplished. The wax is removed at the bottom of the separator.

The part of the ethylene which did not react, the methanol and the waxes still dissolved in this mixture are released tangentially into a vessel through a pressure release valve. In this vessel methanol and wax particles are precipitated. With the decrease of the temperature in the mixture to 40 to 50° C. as a consequence of the release of the pressure, the wax collects in the methanol as a fine suspension. This suspension is syphoned into a distillation column where the methanol

Table I.—Properties of Polyethylenes

Properties	*Grade A*	*Grade B*	*Grade AX*
Tensile strength, kg./mm.²			
Based on original dimensions	0.75	1.0	1.25
Cold drawn	...	4.0	5.50
Softening range, ° C. (ball and ring method)	95 to 105	98 to 108	103 to 113
Viscosity at 200° C., poises	ca. 3000	ca. 30,000	ca. 300,000
Extrusion temperature recommended, ° C.	125	150 to 200	200 to 300
Molecular weight, average (viscosity method)	11,000 to 19,000	18,000 to 26,000	25,000 to 35,000
Brittle temperature in bending, ° C.	...	−38	...
Brittle temperature in impact, ° C.	...	−38	...
Tearing strength and stretch			
New	...	175 lb., 550%	...
Aged at 70° C. for 3 weeks	...	130 lb., 520%	...
Aged at 70° C. for 9 weeks	...	155 lb., 120%	...
Deformation under heat			
At 70° C., percent	...	0.8	...
At 100° C., percent	...	1.5	...
Water permeability	...	0.17×10^{-8}	...
Water absorption after 30 days at 25° C. and 93% relative humidity, percent	...	0.06	...
Melting point, ° C.	...	175	...
Sulfate ash content, percent	...	0.01	...
Specific heat at 25 to 100° C.	...	0.58	...
Specific gravity	...	0.92 to 0.94	...
Coefficient of linear thermal expansion at 20 to 40° C., per ° C.	...	0.000263	...
Breaking index	...	1.52	...
Brinell hardness (10 mm. ball; 50 and 100 kg. load for 30 sec.)	...	2	...
Dielectric constant			
50 cycles	...	2.20	...
10^6 cycles	...	2.20	...
10^7 cycles	...	2.16	...
Power factor			
15,000 cycles	...	0.0005	...
150,000 cycles	...	0.0006	...
Resistance to chemicals	Resistant to concentrated nitric and hydrochloric acids and to 50 percent sodium hydroxide. Sulfuric acid causes slight charring.		



2—*Flow diagram of the Zweckel plant indicates the preparation of I. G. Wax A at 200 atmospheres pressure*

is removed and brought back into the catalyst mixing vessel by way of a condenser. The benzoic acid still dissolved in the wax is blown out with nitrogen after the wax has been removed from the column. The ethylene after the addition of fresh gas is recycled.

The equipment works without any difficulties. Occasional disturbances during the initial period of operation resulted in a brownish colored product and a marked decrease in yield. These were traced to leaks in the centrifugal pump for the caustic soda bath which allowed small amounts of air to be sucked into the system. The parts of the equipment which come in contact with benzoyl peroxide and, after the reaction, with benzoic acid are made of steel (V_2A) or aluminum.

The capacity of the plant at 200 atmospheres operating pressure is 615 kg. of wax per day; at 250 atmospheres it is 10 to 15 percent higher.

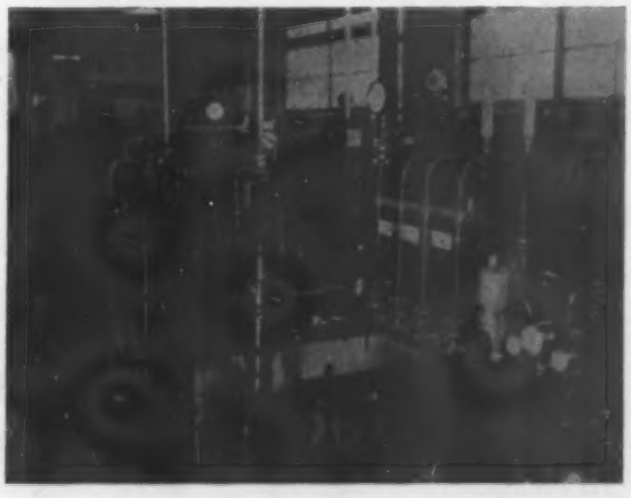
Circulating solution has the following composition:

Methanol	87 percent
Water	10.9 percent[1]
Acid (benzoic)	0.7 milliequivalent per liter
Oil (water-insoluble)	0.5 volume percent
Dry residue	0.14 gram per liter
Peroxide oxygen	Not detectable

The melting point of the wax is 105 to 110° C.

[1] The benzoyl peroxide contains 25 percent water for safety reasons.

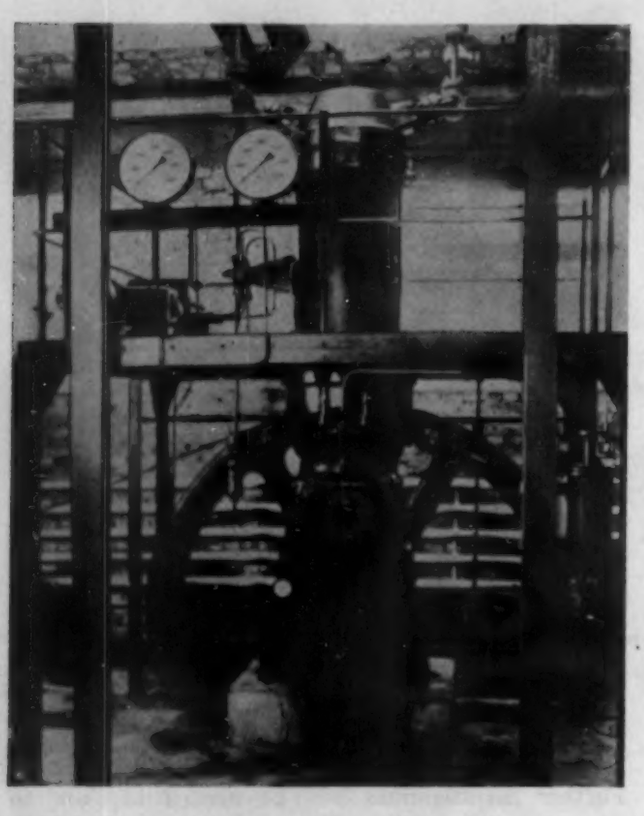
The oxygen content is between 0.7 and 1.3 percent. But the active oxygen introduced as benzoyl peroxide, based on the wax yield, is only 0.4 to 0.5 percent. Further investigations will be needed to show to what degree benzoic acid is contributing to the higher oxygen content of polyethylene. (*Please turn to next page*)



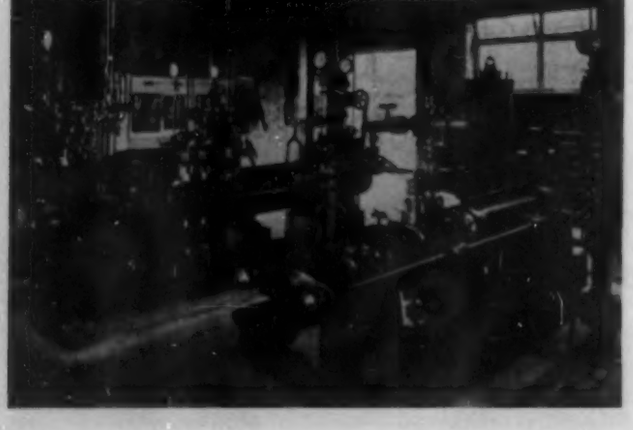
3—*Compressors with an hourly capacity of 20 normal cubic meters installed in experimental plant*

I. G. Wax A has proved to be very satisfactory both as a compounding agent for use with B 200 (polyisobutylene) and as a high-grade wax for the manufacture of polishing waxes and shoe creams.

For use as plastics, especially for cable insulation, only polyethylenes of high molecular weight are of interest. These are produced under high pressures (more than 600 atmospheres). This process is dependent on the I.C.I. patents. The corresponding material made by I.C.I. was found as insulating material on radio equipment on R.A.F. Wellington bombers which were shot down during the war.



4—A two-stage booster compressor from 300 to 4000 atmospheres installed in the 10 tons/mo. plant



5—Liquid pumps for 2000 to 4000 atmospheres which were installed in this same plant

Ethylene polymerization at high pressures

Experiments at 1000 atmospheres—Ethylene with an oxygen content of 0.05 to 0.1 percent as catalyst is compressed to a pressure of 1000 to 2000 atmospheres and polymerized to polyethylene in a coil reactor at 180 to 200° C. The residual gases, after an addition of fresh oxygen, are passed through a caustic soda bath mainly to remove formaldehyde and oil, and recirculated together with fresh gas.

The first polymerization experiments were carried out in horizontal tubes with an internal diameter of 3 or 6 mm. At 1000 atmospheres, very good products were obtained with K-values of 70 to 80 and with folding endurance up to 1000, corresponding to a molecular weight of 15,000 to 20,000. But continuous operation could not be obtained because the pipes were too narrow and became clogged after some time.

Upon a proposal of Dr. Hopff, we changed to vertically arranged pipes and attached a wax separator at every lower elbow. This has the advantage that the viscous polyethylene is easily removed in the descending tubes and that the individual reaction zones can be readily controlled. In order to prevent clogging in the ascending tubes, a smaller diameter pipe (3 to 6 mm.) was used upon the advice of Mr. Reichert to attain an increased speed of flow. But again the pipes became clogged after some time. In spite of this clogging, we think that the vertical arrangement of the tubes is promising because it saves space and the wax is more easily removed.

In further experiments we tried to introduce the gas to be polymerized into a vertical double tube with the same negative result. It was intended that the polymerization take place in the outer 16-mm. tube and that the hot residual gases after removal of the polymer would be passed upward in the inner 8-mm. tube countercurrently to preheat the incoming gas.

Only in tubes with a continuous internal diameter of 10 mm. could a continuous production be achieved without clogging and without pressure differences inside the pipes. The initial polymerization is now done at 180 to 190° C. in a 5-meter vertically ascending tube with circulating hot water heat, and the final polymerization takes place at 90 to 100° C. in another descending tube of equal length. Cooling with circulating water is necessary to remove the heat liberated in the reaction quickly and to prevent decomposition of the products into carbon and hydrogen.

After polymerization, the pressure can be released either directly from 1000 to 0 atmospheres or stepwise from 1000 to 200 atmospheres and subsequently from 200 to 0 atmospheres. If the pressure is released in one step, the polyethylene will precipitate as a powder since the polymer solidifies instantly as a result of the cooling which accompanies the release of the pressure on the unpolymerized ethylene. When the pressure is

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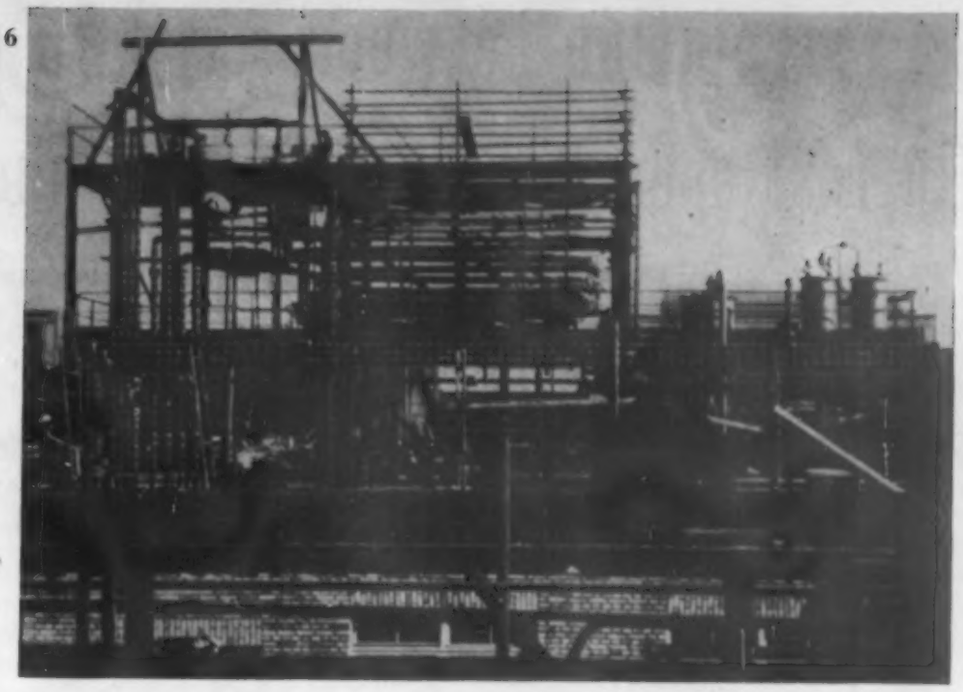

6—Section of a plant which was devoted to the production of high molecular weight polyethylene. 7—This is the plant shown in Fig. 6 as it appeared after being heavily bombed

released in the first step to 200 atmospheres, the polymer is discharged as a liquid in a heated 10-liter separator except for 1 percent of low molecular weight polyethylene which is carried along by the remaining gases and caught in another vessel that is at atmospheric pressure.

Compressors and liquid pumps for ethylene

For the experimental plant we installed an assembly of compressors, as shown in Fig. 3, with an hourly capacity of 20 normal cubic meters. They consisted of an initial compressor 0 to 350 atmospheres, a booster compressor 350 to 1000 atmospheres and another booster compressor 1000 to 2000 atmospheres that are built by Hofer. The compressors had been constructed for nitrogen. In order to be able to drive them in the same way for compressing ethylene, the compressibility of which differs considerably from that of nitrogen, they were equipped with adjustable impulsion. Furthermore, a liquid pump with adjustable impulsion was installed in order to pump the same amount of liquefied ethylene (critical temperature 10° C.) at 1000 to 2000 atmospheres.

The installation for the 10 tons/mo. plant was comprised of two initial compressors with a total capacity of 265 normal cubic meters per hour from 0 to 300 atmospheres, a two-stage booster compressor (Fig. 4) from 300 to 4000 atmospheres built by Maschinenfabrik Esslingen and three liquid pumps (Fig. 5) for 2000 or 4000 atmospheres from the Division for High Pressure Experiments in Ludwigshafen. Since the booster compressor was constructed for nitrogen, only pressures up to 1100 atmospheres could be attained with ethylene on account of its different compressibility. On the other hand liquified ethylene could easily be pumped to 2000 to 4000 atmospheres with the liquid

7

pumps. The feasibility of this method for a permanent installation is still under investigation.

Lubricating difficulties

According to our experience so far, it can be generally stated that ordinary mineral oil is not suitable for lubrication of compressors or pumps for ethylene under high pressures; a large part of the oil is dissolved in the ethylene. As a consequence the pistons soon loosen and the compressors leak.

We used 1,3-butylene glycol successfully for lubrication of the smaller compressors (3 m.³ or 8 m.³/hr. to 200 atmospheres), but its lubricating properties are not sufficient for the larger Hofer compressors (20 m.³/hr.). First, we replaced it with A.B.G. oil (made with adipic acid and butylene glycol). But this slightly acid oil was not advisable for com- (*Please turn to page 188*)

Correlation between strength properties in test specimens and molded phenolic parts*

Part I. Tensile and flexural properties

by P. S. TURNER AND R. H. THOMASON†

Exploration of the nebulous region between standard test and structural performance of molded plastics has been undertaken at the National Bureau of Standards for the National Advisory Committee for Aeronautics.

The tensile, flexural and impact properties of ten selected types of phenolic molding materials have been investigated. The materials were studied to see in what ways and to what extent their properties satisfy some assumptions on which the theory of strength of materials is based: namely, a) isotropy, b) linear stress-strain relationship for small strains and c) homogeneity. The effects of changing the dimensions of tensile and flexural specimens and the span-depth ratio in flexural tests are reported.

Part II, to be published in July, will describe the results of the impact tests on the ten selected phenolic molding materials. The strengths of molded boxes and flexural specimens cut from the boxes will be compared with results of tests on standard test specimens molded from the respective materials.

NO THOROUGH investigation of the relationship between the strengths of molded plastic articles and strength data on their materials has been reported. Most of the available information on the strength properties of molded phenolic plastics have been obtained with standard test specimens and standard methods of test. Specific data of this type, obtained in accordance with test methods established by the American Society for Testing Materials, are published in manufacturers' data books.[1,2]

These sources acknowledge that a "molding material, which on standard test pieces appears superior, may show up in actual production as being even inferior to another material which on standard test pieces reveals a lower order of desirable properties."[1] These discrepancies are further attributed to such factors as peculiarities in mold design, size and shape of the molded article and variations in molding conditions, but not to inherent differences in the materials or to selective characteristics of standard test specimens.

Materials and preparation of specimens

The materials used in this investigation are listed in Table I. Flat sheets were molded from Bakelite phenolic molding materials by the Bakelite Corporation. Rectangular boxes were molded from the same compositions by the General Electric Company. Moldings prepared at the National Bureau of Standards included: dumbbell tensile specimens in accordance with type 1 of Method No. 1011 of Federal Specification L-P-406a; rectangular bars, 1 in. wide and 5 in. long; bars 1/2 by 5 in. for impact specimens; cylinders, 2 in. in diameter and approximately 1 in. in length; and disks, 4 in. in diameter and of various thicknesses.

The specimens molded at the Bureau of Standards were prepared with fully positive hand molds heated by conduction from steam-heated platens. The molding was done with a 50-ton capacity semi-automatic press. Preforms were prepared in the same molds that were used for the particular specimen. Some of the materials did not produce good preforms at room temperature with the pressure available or permissible for the particular mold. Preforms of these materials were made at somewhat elevated temperatures with a hand-operated hydraulic press of 18-ton capacity. The platens were electrically heated and were thermostatically controlled.

All machined test specimens were prepared at the National Bureau of Standards. The tensile specimens were milled with a machine having a cam-operated milling fixture for duplicating the desired contour.

Test procedures and equipment

Tensile tests—These were made in accordance with Method No. 1011 of Federal Specification L-P-406a, except that the rate of separation of the grips was maintained at 0.05 in. per minute and the profile of the specimen specified for thicknesses of 1/4 in. or less was used for all tensile tests.

Flexure tests—These were conducted at the rate of loading specified in Method No. 1031 of Federal Specification L-P-406a for obtaining load-deflection data. In the tests reported in Tables II and III, approximate span-depth ratios were obtained with support and pres-

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* Abridged from National Advisory Committee for Aeronautics Technical Note No. 1005.

† National Bureau of Standards.

[1] Bakelite Molding Material Data Book. Bakelite Corp.

[2] Resinox Molding Materials Data Book. Monsanto Chemical Co.

Table I.—Description of Materials

Manufacturers' designation	*Filler*	*Mean bulk factor[a] (manufacturers' data)*
Bakelite BM-45	Woodflour	2.45
Bakelite BM-120	Woodflour and cotton flock	2.58
Bakelite BM-6260	Woodflour and cotton flock	3.8
Bakelite BM-250	Long-fiber asbestos	8.0
Bakelite BM-200	Macerated fabric	9.5
Bakelite BM-3510	Macerated fabric	14.5
Resinox 7013	Mica	2.64
Resinox 6565	Long cotton flock	5.5
Resinox 6905	Tire cord	6.5
Resinox 6542	Macerated fabric	10.0

[a] Bulk factor is the ratio of the volume of the molding composition to the volume of the finished molding.

sure pieces having loading edges rounded to 1/8 in. radii. This jig, together with a notched spacing and centering plate, provided adjustment at a limited number of positions. Subsequent tests were made with self-centering continuously variable jigs of the type shown in Fig. 1 with attachments for obtaining load-deflection data. The deflections were measured with Southwark-Peters plastics extensometers, Models PS-6 and PS-7, and an autographic stress-strain recorder. The pressure and support pieces of the jig which was used for spans of 2 in. or less, shown in Fig. 1, were rounded to radii of 1/32 in.; those of a larger jig of the same type which was used for spans greater than 2 in. had radii of 1/8 inch.

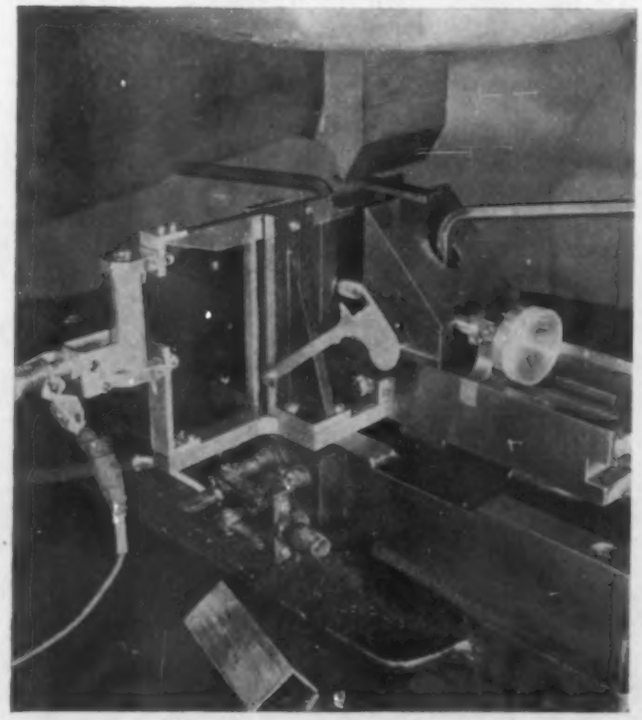
Specimens used in the study of the effect of span-depth ratio were first broken at the largest span. The remaining pieces were used for tests at shorter spans. Care was taken to insure that points highly stressed in the first test did not coincide with points of maximum stress in subsequent tests. Comparisons with specimens which had not been used previously indicated that the portions of the specimens which were used again had not been damaged in the first tests. This method of sampling was used to avoid effects of thickness and cure which might affect the results.

Izod impact tests—The standard Izod impact test was conducted in accordance with Method No. 1071 of Federal Specification L–P–406a on specimens having machined notches. A correction for the energy absorbed in tossing the broken pieces of the specimens was obtained as follows: The broken pieces of the specimens were fitted together and subjected to a second impact. This tossing energy was corrected for friction and windage. It was assumed that the energies imparted to the severed end of the specimen were proportional to the unexpended energies after the Izod and tossing tests. A portion of the tossing energy proportional to the unexpended energy in the Izod test was subtracted from the Izod impact value.

Falling-ball impact tests—Falling-ball progressive-repeated impact tests, similar to Method No. 1074 of Federal Specification L–P–406a, were conducted on 3 1/2 by 4 1/2 in. rectangular sections cut from the molded flat sheets. Preliminary tests were made on 4 in. diameter disks of various thicknesses supported on a cast iron pipe cap. The equipment used for testing the rectangular sections is shown in Fig. 2. The specimens

1—Self-centering continuously variable jigs like this with attachments for obtaining load-deflection data, were used in certain of the flexure tests. 2—This apparatus was used for falling-ball impact test

1



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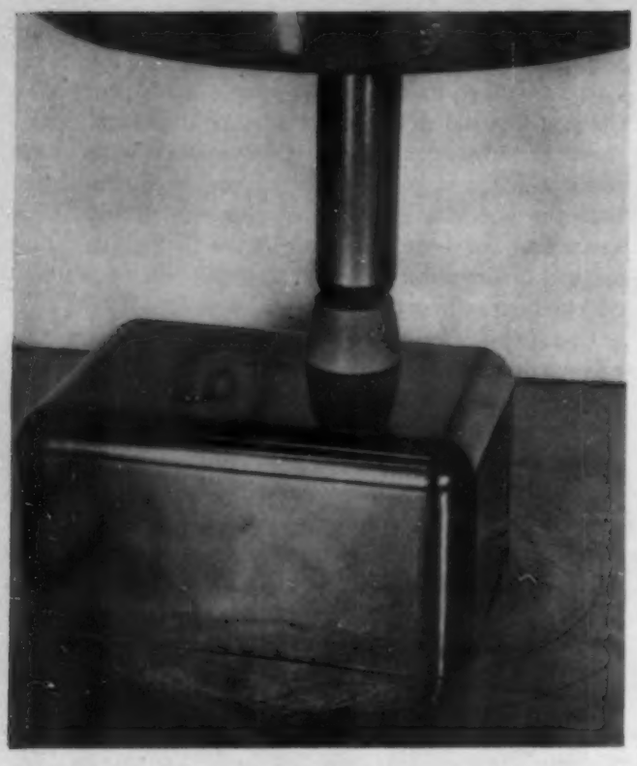


3—*Breaking strength tests on a molded box*

were mounted in a hardwood frame which rested on a flat steel plate. The frame provided a 1/8 in. wide supporting area at the edges. A 1/2 lb. steel ball was used for tests on 1/8 in. thick sheet material and the molded disks; 1/2 and 2 lb. balls were used for testing 1/4 in. thick sheet material. The height of fall was increased in steps of 1 in., starting with the 1 in. height, until complete failure occurred. The energy to crack the specimens also was noted.

Impact-flexural test—Flexural specimens 1/2 in. wide, which were machined from the 1/8 in. thick molded flat sheets, were struck at the center of a 3 in. span with a ball weighing 0.15 pound. The equipment was essentially the same as that shown in Fig. 2 except that a flexural test jig (see Fig. 1) with support pieces rounded to 1/8 in. radii was substituted for the wooden frame. The height of fall was adjusted by successive high-low approximations so as to obtain the height of fall which would crack but not break apart the specimens of a specific material with a single blow. A majority of the specimens received impacts close to the energy required to crack the specimen. All specimens which were not completely broken by the impact were subjected to a flexural test at a span-depth ratio of 8:1 with the load applied at the point of impact.

Tests on molded boxes—Breaking strength tests were conducted on molded boxes using a plunger having a hemispherical end of 5/8 in. radius (as shown in Fig. 3.) The rate of travel of the plunger relative to the base of the boxes was 0.05 in. per minute. The loads were applied in three ways: 1) at the molded hole; 2) at a point on the bottom symmetrically located on the diagonal with respect to the center and the molded hole; and 3) at the latter point through a rubber cushion. The load was not applied at the center of the bottom because of a deeply indented mold number located at that critical point. The rubber cushion was a No. 7 rubber stopper placed with the larger diameter face bearing on the surface of the box (see Fig. 3). No attempt was made to analyze the stresses set up in the boxes by the loads applied.

Conditioning.—All the specimens were conditioned for at least 48 hr. at 25° C. (77° F.) and 50 percent relative humidity and were tested in atmosphere which had been conditioned.

Statistical analysis

The coefficient of variation which is used as a measure of the variability of the materials is based on the most likely estimate of the standard deviation of the parent population.[3] It is calculated according to the formula:

$$V = \frac{\sqrt{\Sigma(d_i)^2/(n-1)}}{\text{Average}} \times 100$$

where

V = coefficient of variation in percent
d_i = deviation of the individual result "i" from the average
n = number of test results

The standard error of the average was calculated according to the formula:

$$\text{S.E.} = \sqrt{\Sigma(d_i)^2 / n(n-1)}$$

The standard error for the difference between two averages was calculated according to the formula:

$$\text{S.E.}_{AB} = \sqrt{\text{S.E.}_A{}^2 + \text{S.E.}_B{}^2}$$

The difference between two averages is considered to be significant if it equals or exceeds $3 \times \text{S.E.}_{AB}$.

Anisotropy of molded phenolic plastics

Standard test specimens and standard methods of test do not, as a general rule, take cognizance of the possibility that molded phenolic plastics may be non-isotropic in the three-dimensional sense. It has been reported that molded thermosetting plastics are generally isotropic.[4]

Visual examination of molded articles of various sizes and shapes indicates that in thin sections long fibers of the filler are oriented in planes parallel to the molded surfaces. In thick sections the fibers tend to be oriented in planes perpendicular to the direction of flow in the molding. Peculiar orientations are found around inserts and at abrupt changes in section thickness. Fibers in gradual changes of section are oriented around the contour of the part. Sketches illustrating the orientation of fibers are shown in Fig. 4.

Differences in the directional properties of the various

[3] W. E. Deming and R. T. Birge, "Statistical theory of errors," Reviews of Modern Physics 6, 145 (July 1934).
[4] "Plastics for Aircraft," Army-Navy-Civil Committee on Aircraft Design Criteria, ANC Bulletin 17 (July 1943).

Table II.—Isotropy of Molded Phenolic Cylinders

Material	Mean bulk factor	Length of cylinder[a]	Flexural strength parallel to ram motion				Flexural strength perpendicular to ram motion				Isotropic index[c]
			Average	Range	Span-depth ratio[b]	No. of tests	Average	Range	Span-depth ratio[b]	No. of tests	
		in.	p.s.i.	p.s.i.			p.s.i.	p.s.i.			
BM-45	2.45	1.30	7900	7500–8300	6.5	6	9,000	8,200– 9,900	6.4	5	0.88
		0.97	7300	6300–7900	8.0[d]	9	8,900	7,600– 9,900	8.0[d]	5	0.82
BM-120	2.58	1.18	8700	7600–9800	7.5	10	10,400	9,600–11,200	6.7	10	0.85
R-7013	2.64	1.12	3600	3100–4400	6.5	5	5,800	4,300– 7,200	7.1	6	0.61
BM-6260	3.8	1.13	7200	5700–8800	7.1	6	9,200	7,500–10,800	6.9	6	0.79
		1.39	7300	6300–7800	8.0[d]	8	9,800	9,000–10,200	8.0[d]	7	0.75
R-6565	5.5	1.63	4400	3600–5800	6.6	8	8,900	7,500–10,900	6.4	6	0.50
R-6905	6.5	1.09	3700	2600–5600	4.5	6	8,200	7,000–10,300	4.5	5	0.45
BM-250	8.0	1.01	3700	3100–4100	6.5	6	10,100	7,900–11,100	7.0	5	0.37
BM-200	9.5	1.07	4500	3400–5600	7.7	6	11,500	10,000–13,700	7.4	5	0.40
R-6542	10.0	1.10	5000	3800–6600	6.3	6	11,800	8,500–13,400	6.2	5	0.43
BM-3510	14.5	1.10	4800	3100–6200	7.2	5	12,400	9,800–14,800	7.7	5	0.39

[a] Cylinders were 2 in. in diameter.
[b] Average ratio for group of nearly uniform specimens; pressure piece and supports had 1/8 in. radii.
[c] The isotropic index is defined as the ratio of flexural strengths of specimens cut with their long axes parallel and perpendicular, respectively, to the direction of the ram motion.
[d] Span adjusted to obtain uniform span-depth ratio; pressure piece and supports had 1/32 in. radii.

phenolic molding materials in the form of molded cylinders, 2 in. in diameter and approximately 1 in. in length, were investigated. Sections cut from these cylinders were of uniform appearance when sanded except that the orientation of long fibers was visible. Fibers in the interior of the cylinders were oriented at random in planes perpendicular to the axis of the cylinders, the direction of the ram motion. Fibers near the surface were oriented parallel to the molded surface.

Flexural specimens of approximately uniform size were cut from the cylinders parallel and perpendicular, respectively, to the axis. Specimens cut from the circular faces were discarded. Rectangular specimens were machined and sanded to uniform thickness within ±0.001 inch.

The results of the flexural strength tests are presented in Table II. All the specimens cut with their long axis parallel to the direction of the ram motion failed with typically brittle breaks. The specimens of the long fiber materials which were cut with their long axis perpendicular to the ram motion broke with "green stick breaks."

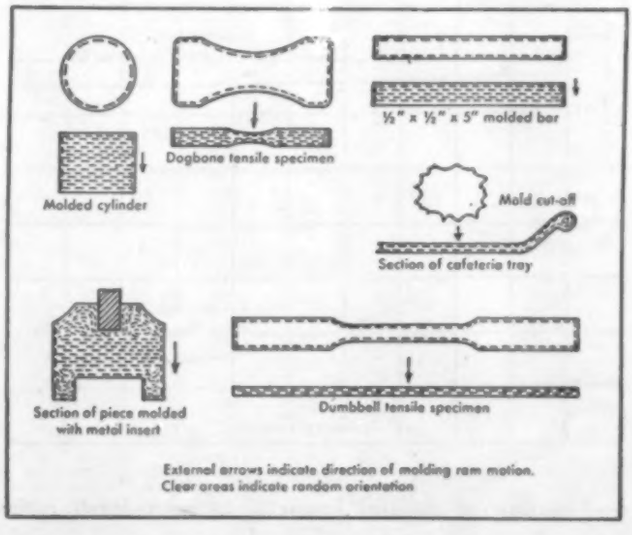
The ratio of the flexural strength of specimens cut parallel and perpendicular, respectively, to the axis of the cylinder is used as an index of isotropy. The variation of this index with the bulk factor of the powder is shown graphically in Fig. 5. The bulk factor is roughly a measure of the size and also of the shape of the filler particles.

Flexural strength *vs.* span-depth ratio

The strength of a structure made of a brittle material

4—Orientations of fibrous fillers in molded shapes

4


½" x ½" x 5" molded bar
Dogbone tensile specimen
Molded cylinder
Mold cut-off
Section of cafeteria tray
Section of piece molded with metal insert
Dumbbell tensile specimen
External arrows indicate direction of molding ram motion.
Clear areas indicate random orientation

5—A chart of anisotrophy of 2-in. cylindrical moldings

5

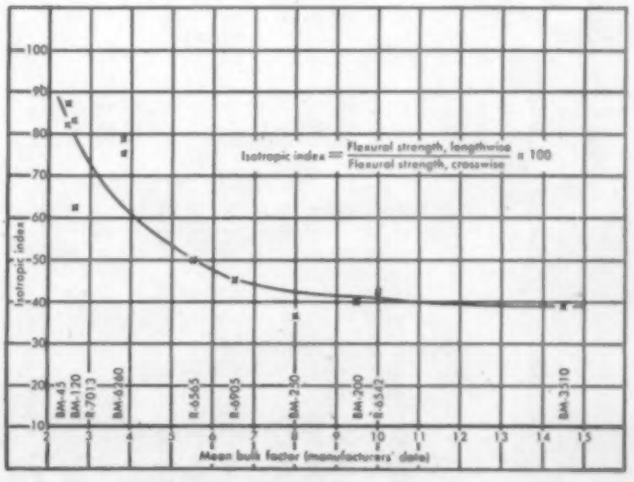


Table III.—Variation of Flexural Strength with Span-Depth Ratio on Molded Phenolic Specimens 1 In. Wide

Material	Average thickness	Average span-depth ratio	Flexural strength				Average span-depth ratio	Flexural strength				Average span-depth ratio	Flexural strength			
			No. of tests	Average	S.E.[a]	V[b]		No. of tests	Average	S.E.[a]	V[b]		No. of tests	Average	S.E.[a]	V[b]
	in.			p.s.i.	p.s.i.	%			p.s.i.	p.s.i.	%			p.s.i.	p.s.i.	%
BM-45 (long cure)	0.170	16.9	6	10,300	±270	6.3	10.5	6	10,500	±280	6.4	6.8	6	11,700	±340	7.0
(short cure)	0.179	16.8	2	10,800	...	...	11.2	2	10,300	...	...	5.6	2	12,100	...	...
BM-120	0.172	17.1	6	10,300	±410	9.6	11.0	5	10,700	±500	10.4	6.2	11	12,100	±170	4.8
BM-200	0.164	18.4	5	11,500	±420	8.2	12.3	5	12,500	±450	8.0	6.2	5	13,300	±820	13.8
BM-250	0.147	16.9	9	11,400	±300	7.9	12.1	3	11,500	...	...	6.2	3	11,800	...	...
	0.128	23.4	3	11,700	...	...	...	..	....	...	...	...	...	...	...	...
BM-3510	0.150	20.1	5	11,700	±750	14.3	13.4	5	12,900	±680	11.8	6.7	5	13,600	±550	9.1
BM-6260	0.188	18.7	6	9,900	±250	6.2	10.1	6	10,800	±270	6.1	6.2	6	11,100	±380	8.4
R-6542	0.175	17.4	5	11,700	±540	10.3	11.6	4	12,600	...	...	5.8	5	13,700	±950	15.5
R-6565	0.174	18.6	6	9,500	±350	9.0	10.5	6	10,400	±480	11.2	7.0	6	11,800	±580	12.0
R-6905	0.172	18.1	5	11,200	±710	14.1	11.4	5	12,900	±740	12.7	6.6	5	13,800	±1240	20.0
R-7013	0.182	16.5	5	6,900	±350	11.3	11.0	5	6,900	±360	11.6	5.6	4	7,200	±250	7.0

[a] S.E. = standard error of the mean.
[b] V = coefficient of variation.

usually is determined in service by resistance to bending, alone or in combination with axial loading.[5] It is generally recognized that the flexural strength (modulus of rupture) varies with the material, the form of the section, the method and rate of loading, the span-depth ratio and, in the case of fibrous materials such as wood, upon the size of the piece. The effect of span-depth ratio on the strength of brittle materials, e.g., cast iron and plaster, is slight[6] except for ratios less than 10.

Few data on the variation of flexural strength with span-depth ratio have been reported for plastics although different specifications require different ratios for testing. Federal Specification L–P–406a requires a minimum span-depth ratio of 16:1. The flexural strength data published in the manufacturers' data books have been determined at a span-depth ratio of 8:1 in accordance with A.S.T.M. methods.

The variation of flexural strength with span-depth ratio obtained on molded specimens of 10 phenolic molding materials is given in Table III. The depth of the beam on these tests was the molded thickness of the sheet. Curves for BM-45, BM-120 and R-6565, which showed statistically significant variations with span-depth ratio, and for BM-250, which showed practically no change, are shown in Fig. 6. The asbestos-filled material, BM-250, and the mica-filled material, Resinox

[5] R. J. Roark and R. S. Hartenberg, "Predicting the strength of structures from tests of plaster models," Univ. of Wis., Eng. Exp. Sta., Bulletin *81*, 25 (1935).
[6] R. J. Roark, "Formulas for stress and strain," McGraw-Hill Book Co., Inc., New York (1938).

6—Variation of flexural strength to span-depth ratio

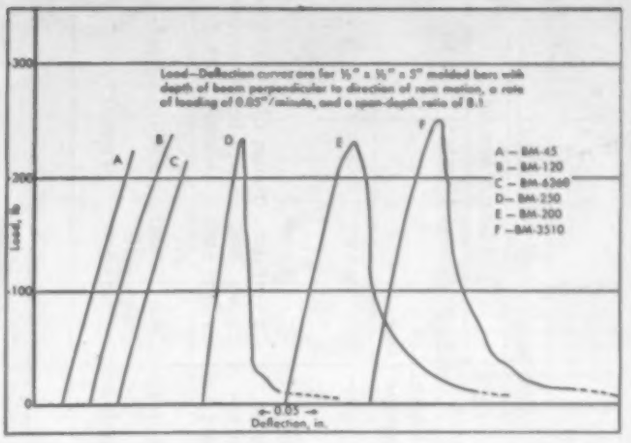
7013, show the least variation with span-depth ratio.

The materials containing large pieces of filler, such as those containing tire cord or macerated fabric, frequently broke at points some distance from the center of the beam. These failures occurred at the junctures of large pieces of filler. The results obtained with those materials were too variable to show a significant variation with span-depth ratio with the number of specimens used.

Although no two materials show the same quantitative variation with span-depth ratio, the flexural strengths of the molded plastics are usually greater for smaller ratios.

The large deflections obtained in the flexure tests of some plastics at large span-depth ratios introduce considerable error into the calculation of the bending moment. The reactions at the support pieces are no longer parallel to the applied load. The component of the moment produced by the sidewise thrust of the support pieces is not considered in the method of calculating prescribed by the Federal and A.S.T.M. specifications. Also when large deflections occur the specimen may slip and increase the actual span length. The magnitude of these errors would be less in tests at a span-depth ratio of 8:1 than at a ratio of 16:1.

The results of flexural tests on specimens cut from flat sheets and on molded bars are listed in Table V. Specimens were prepared from the flat sheets in three widths for both 1/8 and 1/4 in. thicknesses. The flexural strength appears to be independent of the width of the specimen. The 1/4 in. wide specimens of BM-200 and BM-3510 were hard to machine and had burred edges. The burred edges are believed to be the cause of the reduced strength of these specimens.



7—Typical load-deflection curves for molded phenolics

The most noticeable effect is the lower strength obtained with the thicker specimens of the long-fiber materials, BM-250, BM-200 and BM-3510. It should be noted that this effect would invalidate studies of the effect of span-depth ratio in which different ratios are obtained with specimens of different molded thicknesses. The effect does not appear in the case of the woodflour-filled material, BM-45, and gradually becomes more pronounced for increasingly fibrous materials. This selectivity of the thickness effect indicates that it is caused by the fibrous fillers rather than by curing effects.

Typical flexural load-deflection diagrams for six phenolic materials are shown in Fig. 7. Other reports[7]

[7] T. S. Carswell and H. K. Nason, "Effect of environmental conditions and mechanical properties of organic plastics," MODERN PLASTICS 21, 22 (June 1944).

Table IV.—Effect of Thickness and Curing Time on Strength of 4 In. Diameter Disk Moldings of Bakelite BM-120 Phenolic Molding Compound

Nominal thickness of moldings	*Batch no.*	*Curing time*[a]	*Flexural strength*[b]				
			No. of tests	*Average*	*Range*	*S.E.*[c]	*V*[d]
in.		*min.*		*p.s.i.*	*p.s.i.*	*p.s.i.*	*%*
			Minimum cure				
1/16	744C	2	20	12,300	10,500–13,700	±180	6.6
3/32	744C	2	16	11,900	10,600–13,300	±170	5.8
1/8	744C	2	7	11,200	10,000–12,300	±270	6.3
1/8	670	1 1/2	10	10,900	9,300–12,300	±330	9.6
1/4	670	2 1/2	10	12,200	11,200–13,200	±170	4.4
3/8	670	4	8	11,100	9,900–12,500	±300	7.7
			100 Percent overcure				
1/16	744C	4	20	13,200	12,000–15,700	±220	7.5
3/32	744C	4	16	12,700	11,500–14,100	±170	5.5
1/8	744C	4	7	12,200	11,200–13,300	±270	5.8
1/8	670	3	10	11,800	11,100–12,500	±150	4.1
1/4	670	5	10	11,300	9,100–12,400	±380	10.6
3/8	670	8	6	11,000	9,000–11,900	±400	9.6

[a] Molded at 310° F. and 3000 p.s.i.
[b] Tested at a span-depth ratio of 8:1.
[c] Standard error of the mean.
[d] Coefficient of variation.

Table V.—Effect of Dimension of Specimens on Flexural Strength

Material	Batch no.	Type of specimen[a]	Tests at span-depth ratio of 16:1[b]						Tests at span-depth ratio of 12:1[c]						Tests at span-depth ratio of 8:1[c]					
			Dimensions of specimens		Flexural strength				Dimensions of specimens		Flexural strength				Dimensions of specimens		Flexural strength			
			Width, average	Thickness, average	No. of tests	Average	S.E.[d]	V[e]	Width, average	Thickness, average	No. of tests	Average	S.E.[d]	V[e]	Width, average	Thickness, average	No. of tests	Average	S.E.[d]	V[e]
			in.	in.		p.s.i.	p.s.i.	%	in.	in.		p.s.i.	p.s.i.	%	in.	in.		p.s.i.	p.s.i.	%
BM-45	178	B	1.00	0.170	6	10,300[f]	±270	6.3	..	...	..	....	...	..	..	...	..	....	...	..
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	0.5	0.5	..	8,800[g]	...	..
	178	B, F	..	...	..	....	...	..	..	...	..	....	...	..	0.50	0.48	2	10,400	(Range 10,200–10,500)	
	178	B, E	..	...	..	....	...	..	..	...	..	....	...	..	0.48	0.50	2	11,000	(Range 10,600–11,400)	
	182a	S	0.25	0.137	5	11,400	±420	8.3	0.25	0.135	5	11,800	±710	13.4	0.25	0.140	5	12,100	±640	11.7
	182a	S	0.25	0.265	6	11,500	±480	10.2	..	...	..	....	...	..	..	...	..	....	...	..
	182a	S	0.50	0.140	6	11,200	±610	13.4	0.50	0.136	6	11,300	±440	9.6	0.50	0.144	6	11,900	±690	14.1
	182a	S	0.50	0.265	6	11,700	±340	7.1	..	...	..	....	...	..	..	...	..	....	...	..
	182a	S	0.92	0.139	6	11,400	±510	10.9	0.92	0.139	6	11,100	±560	12.4	0.92	0.139	6	11,800	±660	13.7
	182a	S	0.93	0.264	6	11,900	±240	5.0	..	...	..	....	...	..	..	...	..	....	...	..
BM-120	638	B	1.00	0.172	6	10,400[f]	±370	8.7	..	...	..	....	...	..	..	...	..	....	...	..
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	0.5	0.5	..	10,000[g]	...	..
	638	B, F	..	...	..	....	...	..	..	...	..	....	...	..	0.50	0.48	2	11,000	(Range 10,500–11,500)	
	638	B, E	..	...	..	....	...	..	..	...	..	....	...	..	0.48	0.50	2	12,000	(Range 11,600–12,400)	
	744C	S	0.25	0.151	3	13,700	(Range 13,000–14,300)		0.25	0.310	6	12,900[h]	±320	6.2	..	...	..	....	...	..
	744C	S	0.50	0.155	6	13,800	±440	7.9	0.50	0.309	6	12,700[h]	±260	4.9	0.50	0.162	10	14,100	±450	10.1
	744C	S	0.96	0.150	6	13,900	±710	12.5	0.96	0.307	6	12,900[h]	±200	3.9	..	...	..	....	...	..
BM-6260	Unknown	B	1.00	0.188	6	10,200[f]	±230	5.6	..	...	..	....	...	..	..	...	..	....	...	..
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	0.5	0.5	..	10,000[g]	...	..
		B, F	..	...	..	....	...	..	..	...	..	....	...	..	0.50	0.49	2	9,200	(Range 9200–9300)	
		B, E	..	...	..	....	...	..	..	...	..	....	...	..	0.49	0.50	2	10,600	(Range 10,500–10,800)	
	1221	S	0.25	0.138	6	11,800	±380	7.8	0.25	0.138	6	10,800	±150	3.3	0.25	0.138	6	11,200	±380	8.2
		S	0.25	0.268	6	10,000	±340	8.3	..	...	..	....	...	..	..	...	..	....	...	..
		S	0.50	0.138	6	11,200	±360	7.9	0.50	0.134	6	10,600	±330	7.6	0.50	0.142	6	11,300	±530	11.4
		S	0.50	0.268	6	9,600	±250	6.4	..	...	..	....	...	..	..	...	..	....	...	..
		S	0.93	0.138	6	10,400	±480	11.3	0.93	0.138	6	10,400	±300	7.0	0.93	0.137	6	11,200	±390	8.6
		S	0.93	0.268	6	9,800	±300	7.5	..	...	..	....	...	..	..	...	..	....	...	..
BM-250	168C	B	1.00	0.147	6	11,400[f]	±100	1.9	..	...	..	....	...	..	..	...	..	....	...	..
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	0.5	0.5	..	10,000[g]	...	..
	168C	B, F	..	...	..	....	...	..	..	...	..	....	...	..	0.50	0.48	2	11,200	(Range 11,000–11,300)	
		B, E	..	...	..	....	...	..	..	...	..	....	...	..	0.48	0.50	2	11,800	(Range 11,200–12,508)	
	202D	S	0.25	0.136	5	12,800	±240	4.1	0.25	0.137	5	12,700	±890	15.6	0.25	0.136	6	12,000	±880	18.1
		S	0.25	0.266	6	10,300	±670	16.0	..	...	..	....	...	..	..	...	..	....	...	..
		S	0.50	0.135	6	12,800	±890	17.1	0.50	0.134	6	12,700	±980	18.9	0.50	0.136	6	12,800	±680	13.0
		S	0.50	0.267	6	11,000	±260	5.8	..	...	..	....	...	..	..	...	..	....	...	..
		S	0.91	0.134	6	12,500	±640	13.5	0.91	0.133	6	12,500	±700	13.7	0.91	0.136	6	12,800	±580	11.0
		S	0.92	0.267	6	11,400	±300	6.5	..	...	..	....	...	..	..	...	..	....	...	..
BM-200	67a Black	B	1.00	0.164	5	12,000[f]	±330	6.2	..	...	..	....	...	..	..	...	..	....	...	..
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	0.5	0.5	..	9,500[g]	...	..

	S	0.91	0.134	6	12,500	±640	13.5	0.91	0.133	6	12,500	±700	13.7	0.91	0.136	6	12,600	±360	11.6										
	S	0.92	0.267	6	11,400	±300	6.5	..	...	..	....	...	..	..	...	..	....	...	..										
BM-200	67a Black	B	1.00	0.164	5	12,000[c]	±330	6.2	..	...	..	....	...	..	..	..	...	..	....	...	..									
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	..	0.5	0.5	..	9,500[d]	...	..								
	67a Black	B, F	..	...	..	....	...	..	..	...	..	....	...	..	..	0.50	0.49	2	10,900	(Range 9900–12,000)									
		B, E	..	...	..	....	...	..	..	...	..	....	...	..	..	0.48	0.50	2	11,600	(Range 11,600–11,700)									
	27 Brown	S	0.24	0.145	6	10,700[b]	±770	17.6	0.25	0.144	6	10,600[b]	±910	21.0	0.25	0.146	6	11,000[b]	±720	16.0									
		S	0.25	0.255	6	8,600[b]	±400	11.3	..	...	..	....	...	..	..	...	..	..	....	...									
		S	0.50	0.144	6	13,300	±1100	20.7	0.50	0.143	6	11,700	±340	7.1	0.50	0.145	6	12,100	±420	8.4									
		S	0.50	0.254	6	10,000	±680	16.7	..	...	..	....	...	..	..	...	..	..	....	...									
		S	1.01	0.143	6	13,100	±850	16.0	1.02	0.143	6	11,800	±930	19.4	1.02	0.144	6	12,100	±1200	24.3									
		S	1.02	0.252	6	10,200	±160	4.0	..	...	..	....	...	..	..	...	..	..	....	...									
BM-3510	1660F	B	1.00	0.150	5	12,600[c]	±790	14.0	..	...	..	....	...	..	..	...	..	..	....	...									
	Unknown	B	..	...	..	....	...	..	..	...	..	....	...	..	0.5	0.5	..	9,000[d]	...	..									
	1660F	B, F	..	...	..	....	...	..	..	...	..	....	...	..	0.50	0.50	2	11,600	...	..									
		B, E	..	...	..	....	...	..	..	...	..	....	...	..	0.49	0.50	2	12,000	(Range 11,500–12,500)										
		S	0.25	0.135	6	12,600[b]	±600	11.7	0.25	0.135	6	11,400[b]	±780	16.8	0.25	0.135	6	9,800[b]	±330	8.4									
		S	0.25	0.266	6	10,000[b]	±460	11.2	..	...	..	....	...	..	..	...	..	..	....	...									
		S	0.50	0.135	6	12,000	±840	17.1	0.50	0.136	6	10,800	±650	14.8	0.50	0.134	6	12,700	±900	17.4									
		S	0.50	0.265	6	10,600	±510	11.9	..	...	..	....	...	..	..	...	..	..	....	...									
		S	0.99	0.134	6	12,300	±420	8.3	0.99	0.135	6	12,500	±1000	20.1	0.99	0.134	6	11,200	±770	16.8									
		S	0.98	0.264	6	11,000	±580	13.0	..	...	..	....	...	..	..	...	..	..	....	...									

[a] B = molded bar; S = machined from flat sheet; F = flatwise (depth in direction of molding ram motion); E = edgewise (depth perpendicular to molding ram motion). [b] Tested with 1/8 in. radii support and pressure pieces. [c] Tested with 1/32 in. radii support and pressure pieces. [d] Standard error. [e] Coefficient of variation. [f] Interpolated values from tests at approximate span-depth ratios. [g] Data from manufacturers' Technical Data Book. [h] Specimens had burred edges.

8—Variation of flexural strength with thickness and cure of moldings

show similar contrasting curves for woodflour- and fabric-filled materials. The flexural test emphasizes the differences between the materials. In the flexural test the failure of a surface fiber in tension will produce a succession of beams of diminishing depth which will offer diminishing resistance to the motion of the loading device. The materials containing short fibers offer little resistance to the progress of the failure through the beam and consequently show brittle failures. The type of failure depends on the degree of orientation of the fibers across the fracture.

Additional studies of the effect of thickness and curing time on flexural strength were made with BM-120, a molding material which showed only a slight difference between thicknesses of 1/8 and 1/4 inch. Specimens were taken from 4 in. disks molded in thicknesses between 1/16 and 3/8 inch. Disks were molded for the minimum length of time required to produce sound moldings and for twice that length of time. The results of the flexural strength tests are given in Table IV and shown graphically in Fig. 8. Those data show that minimum and double cures make only a slight difference for this material. The effect of thickness becomes more pronounced for 1/16 and 3/32 in. thicknesses which are more nearly comparable to the lengths of the fibrous filler in this material.

Tensile tests with different specimens

The data for tensile strength which are published in manufacturers' data books have been obtained using the "dogbone" specimen described in Method No. 1012 of Federal Specification L–P–406a and in A.S.T.M. Method of Test D 651–42T. The use of the "dumbbell" specimen described in Method No. 1011 of Federal Specification L–P–406a and A.S.T.M. Method of Test D 638–42T has been considered for replacing the dogbone specimen by A.S.T.M. Committee D-20 on Plastics. The two specimens are shown in Fig. 4. The reports on the comparative test data have been found to be inconsistent. (*Please turn to next page*)

Table VI.—Tensile Strength Determined with Different Types of Specimens (Rate of head motion for NBS tests with dumbbell specimens was 0.05 in./min.)

Material	Molded dumbbell specimens					Molded dogbone specimens					Machined dumbbell specimens			
	Average thickness	No. of specimens	Tensile strength			No. of specimens	Reduced section	Tensile strength			No. of specimens	Average thickness	Tensile strength	
			Average	S.E.[a]	V[b]			Average	S.E.[a]	V[b]			Average	S.E.[a] V[b]
	in.		p.s.i.	p.s.i.	%		in.	p.s.i.	p.s.i.	%		in.	p.s.i.	p.s.i. %
BM-45	0.181	5	6950	±160	5.2	..	..	6000[c]	...	..	6	0.133	7850	±280 8.8
BM-120	..	..	...	...	..	..	..	...	...	..	6	0.261	7240	± 60 2.0
	0.167	7	6510	±200	8.2	..	1/8	8500[c]	...	..	6	0.146	8130	±140 4.2
	1/8	12	6990[d]	±240	11.6	6	1/8	8460[d]	±170	4.9	6	0.302	7910	±130 4.0
	1/4	12	6610[d]	±180	9.6	..	..	8420[d]	±150	4.3	..	..	..	.. ..
	1/8	20	5650[d]	±190	14.8	..	..	...	...	..	..	...	...	... ...
	1/4	20	7070[d]	±190	12.0	..	..	...	...	..	..	...	...	... ...
R-7013	0.212	5	3240	±140	9.9	..	..	6500[c]	...	..	..	...	...	... ...
BM-6260	0.154	9	6750	±150	6.7	..	..	8500[c]	...	..	6	0.135	6530	±220 8.3
	1/8	12	6620[d]	±300	15.9	6	1/8	8160[d]	±220	6.6	6	0.264	6910	±140 5.1
	1/4	12	7340[d]	±200	9.3	6	1/4	7800[d]	±170	5.5	..	...	...	... ...
R-6565	0.224	8	5250	± 70	3.9	..	..	7500	...	..	..	...	...	... ...
R-6905	0.193	8	4260	±160	10.5	..	..	6500[c]	...	..	..	...	...	... ...
BM-250	0.149	7	4840	±130	8.4	..	..	6000[c]	...	..	6	0.133	6900	±250 9.0
	0.149	3	3000[c]	±700	41.0	..	..	...	...	..	6	0.267	6870	±190 6.9
BM-200	0.180	8	5830	±110	5.4	..	..	6700[c]	...	..	6	0.143	4950	± 70 3.3
	..	..	...	...	..	..	..	...	...	..	6	0.250	5730	±200 9.0
R-6542	0.180	7	5800	±140	6.2	..	..	7500[c]	...	..	..	...	...	... ...
BM-3510	0.182	8	5910	±170	8.1	..	..	6500[c]	...	..	..	...	...	... ...
	..	..	...	...	..	..	..	...	...	..	6	0.134	5410	±230 10.5
	..	..	...	...	..	..	..	...	...	..	6	0.263	5710	±150 6.4
	..	..	...	...	..	..	..	...	...	..	7	1/8	6070[f]	±160 6.8

[a] S.E. = standard error of the mean. [b] V = coefficient of variation. [c] Data from manufacturers' bulletins. [d] Test data received from Bakelite Corp. [e] Specimens were molded without the use of preforms; all other NBS specimens were molded from preforms. [f] Test data from Bell Telephone Laboratories; rate of head travel 0.10 in. per min.

9—Effect of direction of molding pressure on the flexural modulus of elasticity of molding powders with various bulk factors

Comparative tensile test results obtained with molded dumbbell specimens, dumbbell specimens machined from 1/8 and 1/4 in. thick molded sheets, and results obtained in other laboratories with both specimens are listed in Table VI. Data from the manufacturers' bulletins are included for comparison. In general, the dogbone specimens indicate higher strengths with lower coefficients of variation. Almost without exception larger specimens of both shapes show lower coefficients of variation. The significance of the questioned generally because of the rather odd shape of the test piece.

The most variable results with dumbbell specimens molded at the National Bureau of Standards were obtained with Resinox 6905, a material containing chopped tire cord. The pieces of tire cord have lengths varying between 1/2 and 3 inches. In the molded dumbbell specimen the lengths of cord have a preferred orientation along the length of the specimen. The strength of a specimen would be high if a number of the longer lengths extended through the reduced section and low if, as a matter of chance, none of these lengths bridged the distance.

The failure of the specimens of this material differed from the failures of the other materials in that the specimens were not completely severed. The dogbone specimen would permit most of the cords to be anchored in the ends of the specimens. The dogbone specimen would, therefore, be expected to give results which are higher.

None of the other materials contain pieces of filler long enough to bridge the reduced section of the dumbbell specimen, but many of the materials contain fibers sufficiently long to bridge the reduced section of the dogbone specimen. These materials show much lower strengths with the dumbbell specimen. The wood-flour-filled material, the fibers of which are too short to bridge the reduced section of either specimen, shows a greater strength with the (*Please turn to page 184*)

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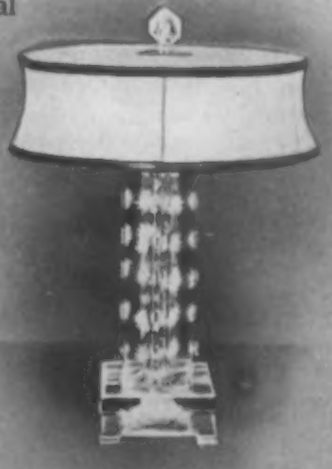

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General

DORON ARMOR. E. C. Fetter. Chem. & Met. Eng. *53*, 154–7 (Feb. 1946). The development, construction, production and properties of a plastic armor called Doron are described. This material consists of glass fabric bonded with thermosetting polyester-styrene copolymers. Doron surpassed any metallic armor in ballistic efficiency and was used as body armor inserts in jackets. Doron, 1/8 in. in thickness, will stop flak and 45-cal. tommy-gun or pistol bullets but not rifle or machine gun bullets.

RESISTANCE OF SYNTHETIC RUBBERS AND RESINS TO BACTERIA, FUNGI, INSECTS AND OTHER PESTS. T. R. Dawson. J. Rubber Research *15*, 1–9 (Jan. 1946). The effects of bacteria, fungi, insects and other pests on polyvinyl alcohol, polystyrene, polyisobutylene, polyacrylates, polymethacrylates, polyvinyl chloride, polyvinylidene chloride, polychloroprene, thioplasts, coumarone resins, alkyd resins, phenolic resins, styrene-maleic anhydride resins, butadiene-acrylonitrile copolymers, vinyl chloride-acetate copolymers, polyamides, ketone-aldehyde resins, urea-aldehyde resins and casein-formaldehyde plastics are reviewed. Included are 152 references.

ADVANCES IN PLASTICS IN THE UNITED STATES AND GERMANY. W. C. Goggin. Chem. and Eng. News *24*, 339–43 (Feb. 10, 1946). The German plastics industry and its products are compared with those of the United States. The topics include vinyl chloride and copolymers, polystyrene, acrylates, cellulose derivatives, polyamides, phenolics, urea resins, vinylidene chloride and copolymers, chlorinated polyvinyl chloride, vinyl ethers, isocyanates, silicones, polyvinyl carbazole, allyl resins and plastic foams.

WHAT PROTECTIVE COATING MAKERS WOULD LIKE FROM THE CHEMICAL INDUSTRY. R. F. Ruthruff. Chemical Industries *58*, 241–5 (Feb. 1946). The properties of new chemical products wanted by the coating industry for use in protective coating formulations are discussed. These include 1) inexpensive odorless powerful solvents, 2) thinners with a more pleasant odor, 3) pigments of good hiding power which are easily dispersed, 4) pigments with improved color retention, 5) extenders with better colors, with low oil adsorption and inert with respect to the binders, and 6) non-convertible binders which are flame-retarding, soluble in inexpensive solvents and compatible with many convertible binders. The properties of the alkyd resins, the polycarboxylic acids, the polyhydric alcohols and the bodied oils are discussed in this article.

WRITING INK. R. S. Casey, Chemical Industries *58*, 246–9 (Feb. 1946). The raw materials, technology, economics and current trends of writing inks are discussed. Nineteen references.

DEVELOPMENTS IN TEXTILES IN 1945. M. Harris and G. Frankenberg. Chem. and Eng. News *24*, 327–9 (Feb. 10, 1946). Developments in textiles during 1945 are discussed. The topics include finishes, waterproof and water-repellent fabrics, textiles and plastics, synthetic fibers, processing and future trends. The whole emphasis of the textile fiber industry has shifted rapidly from clothing and equipping of our armed forces to production of materials for civilian consumption. Contrary to public opinion, the consumer is not going to be presented at this time with revolutionary fabrics or types of clothing that are especially unusual.

Materials

COPOLYMERIZATION OF STYRENE AND ALLYL CHLORIDE. T. Alfrey and J. G. Harrison, Jr. J. Am. Chem. Soc. *68*, 299–301 (Feb. 1946). Mixtures of styrene and allyl chloride were found to copolymerize; the rate of polymerization and the polymerization degree of the copolymer decrease regularly with increasing concentrations of allyl chloride. In this copolymerization reaction, allyl chloride monomer adds to styrene-free radical or to allyl chloride-free radical much more slowly than does styrene monomer.

MELAMINE GLASS-CLOTH LAMINATES PROPERTIES AND MACHINABILITY. P. C. Fuller. Product Eng. *17*, 142–5 (Feb. 1946). The physical and electrical properties of glass-fabric melamine-formaldehyde laminates are described. These materials are outstanding in their arc and heat resistance. They are being used by the Navy on ships as coil spacers, pole collars, mounting boards, panels, terminal plates, blocks for generators and motors, brush holders, washers, connector strips and brush tube caps. Detailed information on sawing, drilling, tapping, turning, sanding, milling, shearing and punching these plastic materials is given.

LOW-PRESSURE RESINS. R. C. Evans and C. L. Jones, Jr. Modern Packaging *19*, 140–2 (Jan. 1946). The properties of the allyl ester resins are described. The production of radomes from glass fabric and these resins is described briefly herein.

RAPID VULCANIZATION OF SATURATED ACRYLIC ELASTOMERS. W. C. Mast, T. J. Dietz and C. H. Fisher. India Rubber World *113*, 223–8, 235 (Nov. 1945). Ethyl acrylate was emulsion polymerized with chloro- and bromoalkyl acrylates. After purification, the copolymers were milled, combined with various accelerators and reinforcing agents and then cured under heat and pressure. The tensile strength, elongation, Shore Durometer hardness, modulus and permanent set of the rubber-like products are reported. Curing times of the order of 30 to 240 min. at 298° to 320° F. were used.

COPOLYMERIZATION OF UNSATURATED CELLULOSE DERIVATIVES. S. N. Ushakov. Otdel. Khim. Nauk i Otdel. Fiz.-Mat. Nauk *1*, 35–6 (1943); Chem. Abstracts *40*, 458 (Jan. 1946). Ethylvinylcellulose is synthesized from ethyl cellulose and ethylene oxide or ethylene chlorohydrin. Alkali cellulose is heated with ethyl chloride and allyl bromide to yield mixed ethylallylcelluloses. Ethylvinylcellulose copolymerizes with maleic esters. Ethylallylcellulose reacts with sulfur dioxide.

PYROLYTIC PREPARATION OF α-CARBALKOXYALYKYL ACRYLATES AND METHACRYLATES. E. M. Filachione, J. H. Lengel and C. H. Fisher. J. Am. Chem. Soc. *68*, 330–3 (Feb. 1946). Several α-carbalkoxyalkyl acrylates and methacrylates were prepared by pyrolyzing the α-acetoxypropionate of methyl glycolate and methyl lactate and the α-acetoxyisobutyrate of methyl glycolate, methyl lactate and ethyl lactate. The relation between ester structure and thermal stability is discussed. When emulsion polymerized, the acrylate of methyl glycolate yielded a soft and pliable polymer that became brittle at 15° to 20° C. Mass polymerization occurred readily when a sealed tube of the monomer containing 1 percent benzoyl peroxide was allowed to stand at room temperature. The polymer

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was soluble in acetone, ethyl acetate, methyl lactate, dioxane, nitromethane and ethylene chloride; the last two compounds seemed to have the highest solvent power. The polymer was insoluble in toluene, β-butoxyethyl acetate, heptane, ethanol and water. When the emulsion of the polymer of the methacrylate of methyl glycolate was coagulated, the polymer separated as a fine powder. At approximately 65° C. the polymer agglomerated, yielding a granular product. Mass polymerization in a sealed tube at 63° of monomer containing 0.1 percent benzoyl peroxide yielded a transparent, colorless casting in a few hours. The polymer was hard at room temperature but softened between 52° and 58° C. A hard polymer was obtained also by heating the monomer in the absence of benzoyl peroxide at 63° C. overnight. The polymer gelled without dissolving in acetone, ethyl acetate, methyl lactate, dioxane, nitromethane, ethylene chloride and β-butoxyethyl acetate. It swelled slightly in toluene, and was insoluble in heptane, ethanol and water.

Applications

HOLOPLAST. British Plastics *18*, 14–20 (Jan. 1946). Holoplast is made by molding round tubes of kraft paper which has been impregnated with phenolic resin, forming the round tubes into rectangular tubes and facing a bank of these rectangular tubes with sheets of flat laminates. Thus a hollow board with partitions at regular intervals is produced. This material is strong, stiff and light and has been used for interior construction on naval vessels.

STRUCTURAL MATERIALS MADE FROM FIBERGLAS FABRICS. J. Reeves. Textile World *95*, 110–12 (Oct. 1945). Plastics reinforced with glass fabrics are described and applications considered. Combinations of glass-cloth-reinforced plastic faces with a lightweight cellular core have possibilities in production of truck and trailer bodies, airplanes, boats and portable houses. Fiberglas must be heat treated before it can be used to best advantage.

PLASTIC OVERLAYS FOR DOUGLAS FIR PLYWOOD. J. D. Long. Paper Trade J. *120*, 44–6 (Mar. 22, 1945). A new combination material consisting of resin-impregnated pulp, paper and fabric hot-pressed to the surface of wood veneer and plywood was put into production. Currently only two types of these "overlay" materials are in production, but laboratory experiments indicate the post-war production of a wide range of materials for various optical, physical and chemical characteristics. The overlay materials consist of carrier sheets which have been impregnated with thermosetting resins which are polymerized to a stable, easily-handled form in the sheet. These are placed on the two faces of the veneer or plywood, covered with suitable sheet metal cauls and placed in flat-platen hot presses. Under proper hot-press assembly, selected for the resin and assembly in question, the plastic overlay fuses to the wood base. The carrier sheets exhibiting the most attractive possibilities are pulp and pulp screening sheets of 15 to 50 points thickness, and paper sheets of 5 to 10 points. The former usually carry resin impregnations of 15 to 35 percent, and the latter 35 to 70 percent. Phenol-formaldehyde, dimethylolurea and melamine resins are currently of greatest interest. The finished panels present smooth, durable faces with colors or patterns as desired. The natural wood grain may show through the face or be entirely masked. It is possible to impress a texture or die into the face. The lower resin content overlays particularly serve as excellent bases for paint and enamel finishes. Laboratory work is in progress to determine the various physical and chemical properties, and the fabrication characteristics of the wide range of such assemblies.

ALGINATE FIBERS COMPARED. C. K. Tseng. Textile World *95*, 113 (Dec. 1945). The properties of fibers made of alginic acid and calcium, aluminum, chromium and beryllium alginates are reported in tabular form.

LAMINATED WINDOW DESIGNS FORECAST BY PLASTIC DOMES. L. M. Purdue and G. E. Hughes. Aviation *45*, 81–3 (Jan. 1946). Aircraft windows made of methyl methacrylate plastic laminated with a polyvinyl butyral core showed satisfactory performance in severe tests. The tests which simulated actual flight and combat conditions are described. This window material is particularly outstanding in resistance to breakage and explosive failures. It is recommended for pressurized enclosures.

ALGINATE "RAYONS" ARE DISTINCTIVE NEW FIBERS. P. Ripley. Textile World *95*, 112–13 (Dec. 1945). The alginate fibers are described. Various types are produced in a manner similar to viscous rayons. None will burn and some are soluble. The breaking strength is about 2 grams per denier. These developments, which utilize seaweed, are mostly British.

ALKYD RESINS AS BONDING AGENTS. G. Leffingwell and M. A. Lesser. Can. Chem. & Process Ind. *30*, 32, 84 (Jan. 1946). The applications and properties of alkyd resins are reviewed. Particular stress is placed on applications in adhesive compositions. Thirty-six references.

DEVELOPMENT OF WEATHERPROOF SOLID FIBER BOARD. H. T. Barker. Paper Trade J. *120*, 47–9 (Mar. 22, 1945). A brief survey of the development of weatherproof solid fiberboard is traced. Typical make-ups of V boards are described and sizing specifications for their paper components are given. The two most extensively used weatherproof adhesives, starch and polyvinyl alcohol, are discussed and their preparation briefly described. Several thoughts on postwar applications of weatherproof solid fiberboards are suggested in this informative article.

GERMAN SYNTHETIC INSULATION FOR WIRE AND CABLE. India Rubber World *113*, 219–21, 230 (Nov. 1945). This report describes the properties and composition of synthetic insulation for wire and cable used in Germany. Butadiene-styrene copolymers and polyvinyl chloride plastics were the principal base materials for compounding insulating materials.

Coatings

USE OF CELLULOSE DERIVATIVES IN WATER PAINTS. Am. Paint J. *30*, No. 6A, 19 (1945). Methylcellulose, sodium carboxymethylcellulose, aluminum carboxymethylcellulose, hydroxymethylcellulose, alginic acid, sodium alginate and ammonium alginate are used as thickeners, protective colloids and film-formers in water paints.

CHOICE OF ORGANIC FINISHES. P. W. Prouty. Paint Varnish Production Mgr. *25*, No. 10, 258–68 (1945). The testing procedures for evaluating coatings and the value of the measurements are discussed.

ORGANOSILICON COMPOUNDS. Am. Paint J. *30*, No. 6A, 7–14 (1945). The applications of ethyl silicate, silica organosol and silicone resins in coatings are described. Ethylcellulose, polystyrene and the polyacrylates are compatible with the silicone resins.

WHAT EVERY PAINT AND VARNISH CHEMIST SHOULD KNOW ABOUT FUNGICIDES. A. Minich and H. M. Johnson. Am. Paint J. *30*, No. 6B, 12–16 (1945). Fungicides for use in coatings for cellulosic materials are discussed in this article.

PROTECTIVE SURFACING OF MAPS AND CHARTS. A. G. Brown. Can. Chem. & Process Ind. *30*, 27–8 (Jan. 1946). Pigmented transparent lacquers for coating maps and charts were developed. The coated materials are capable of being marked with pencil or ink and the markings are easily erased, preparing the map or chart for new markings. The lacquers reported are based on ethyl cellulose, vinyl chloride acetate copolymers and cellulose acetate. The refractive index of the pigment is close to that of the particular plastic-plasticizer combination and the size of the pigment particles in the range 3 to 25 microns.

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Technical Briefs

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments.

Engineering

STYRENE PRODUCTION BY CATALTYIC DEHYDROGENATION. LOW-PRESSURE OPERATION. J. M. Mavity, E. E. Zetterholm and G. Hervert. Trans. Am. Inst. Chem. Engrs. *41*, 519–28 (1945). The various factors affecting the catalytic dehydrogenation of ethylbenzene to styrene are discussed. Ultimate yields of 90 percent may be obtained by this method.

EQUIPMENT FOR TREATING PAPER OR PAPERBOARD WITH RESINS. F. W. Egan. Paper Trade J. *121*, 29–32 (Oct. 4, 1945). The treatment of paper or paperboard with phenolic, urea, silicone, acrylic or other resins can be accomplished by using one of the following methods: 1) dip and flow, 2) absorption, 3) pressure impregnation, 4) saturation and 5) heat. The mechanical handling of paper or paperboard is considered from the unroll equipment, through the treater, the drying process, the guiding of the web, the control of the tension and the winding of the web, in a general manner. The different methods of treating the paper are evaluated. The standard treating operations are analyzed and the results defined.

COATING PROCESSES AND EQUIPMENT. F. W. Egan. Paper Trade J. *121*, 49–54 (Oct. 25, 1945). The methods that can be used in applying coatings in the conventional manner and on a paper machine are reviewed and the equipment evaluated in brief. The ten conventional basic methods of coating are 1) dip, 2) knife, 3) cast, 4) roll, 5) brush, 6) air brush, 7) spray, 8) print, 9) extruding and 10) strip. The effects of coating on a paper machine are considered with regard to changes that must take place in the design of the paper machine so that it will produce paper with a surface that has high printing quality.

TEMPERATURE-INDICATING PAINTS. L. C. Tyte. Proc. Inst. Mech. Engrs. (London) *152*, 226–31 (1945). The properties and formulation of temperature-indicating paints are reviewed. Fourteen references.

Chemistry

FLUIDITY OF NYLON SOLUTION IN *m*-CRESOL. J. Boulton and D. L. C. Jackson. J. Soc. Dy. Col. *61*, 40–7 (Feb. 1945). *m*-Cresol is superior to formic acid in flow properties, viscosity, sensitivity, stability and convenience for use as a solvent for viscosity measurements on nylon solutions. The effects of attack by sulfuric acid and photochemical degradation on various nylon yarns were determined from viscosity measurements on *m*-cresol solutions.

RADICAL CHAIN PROCESSES IN VINYL AND DIENE REACTIONS. H. S. Taylor and A. V. Tobolsky. J. Am. Chem. Soc. *67*, 2063–7 (Dec. 1945). A general mechanism for various reactions of vinyl and diene polymers is presented. This emphasizes the role of the hydrocarbon-free radical as the activated state which can undergo various competing subsidiary reactions that profoundly affect the physical properties of these materials. The mechanism further emphasizes the chain characteristics of depolymerization processes, occurring by reversal of the steps in the chain growth processes, at velocities which are significant even at moderate temperature owing to the small activation energies involved.

IMPROVED TYPES OF PREPARATION OF "PERMSELECTIVE" COLLODION MEMBRANES COMBINING EXTREME IONIC SELECTIVITY WITH HIGH PERMEABILITY. H. P. Gregor and K. Sollner. J. Phys. Chem. *50*, 53–70 (Jan. 1946). The method of Carr and Sollner for the preparation of "permselective" collodion membranes which combine great permeability with extreme ionic selectivity over wide concentration ranges was improved. Under carefully controlled conditions of temperature, speed, etc., highly porous three-layer collodion membranes are cast on the outside of rotating tubes and oxidized with 1 *M* sodium hydroxide for specified periods (8 to 14 min.). The membranes are dried in air of controlled relative humidity while they are still on the tubes; after removal they are ready for use. By varying the conditions of their preparation different types of "permselective" collodion membranes can be prepared, the exact properties of the various types being well reproducible. The "characteristic concentration potential" 0.1 *M* KCl/0.01 *M* KCl across most types of these membranes reaches the theoretically possible maximum of +55.1 mv. The bi-ionic potential in the membrane chain 0.1 *M* KCl/0.1 *M* LiCl varies with these membranes from about +40 to > +60 mv. according to the type of membrane. The ohmic resistance of "permselective membranes" per 100 cm.^{2} in 0.1 *M* KCl can be adjusted at will to any value greater than 1 ohm. There is a positive correlation between resistance and bi-ionic potential. The membranes described may be swelled under controlled conditions in 45 to 85 percent aqueous ethyl alcohol; this treatment increases their permeability and reduces their ionic selectivity. The characteristic concentration potential and the bi-ionic potential across these membranes and their ohmic resistance are thereby reduced to a reproducible extent, according to the selected conditions. Some of the properties of various types of "permselective" membranes are presented in tables.

GENERAL THEORY OF THE REACTION LOCI IN EMULSION POLYMERIZATION. W. D. Harkins. J. Chem. Phys. *14*, 47–8 (Jan. 1946). A theory to explain how minor loci can act in emulsion polymerization is discussed.

Properties

ELECTRICAL PLASTICS IN U. S. A. E. E. Halls. Plastics (London) *10*, 25–32, 68–73 (Jan., Feb. 1946). The electrical properties of the plastics made in the U. S. A. are reviewed. For highest electrical performance where dielectrical properties are of paramount importance the pure hydrocarbons, such as pure polystyrene and polythene, are the best materials available. Marked improvements in dielectric properties are improbable. It is expected that future developments will improve the physical properties without sacrificing electrical properties. A list of 29 references is given, covering test methods, research and patents.

METHODS OF CALCULATING AND REPRESENTING RHEOLOGICAL PROPERTIES, USING DATA FROM THE PARALLEL-PLATE PLASTIMETER. J. R. Scott. J. Rubber Research *14*, 195–8 (Dec. 1945). A tentative method is described for obtaining, from the readings of the parallel-plate (Williams) plastimeter, the fundamental flow relation of the material under test, and for representing this relation graphically in a manner that will facilitate comparisons between different materials.

ELASTIC LOSS RELAXATION TIMES IN CROSS-LINKED POLYMERS. J. G. Kirkwood. J. Chem. Phys. *14*, 51–6 (Feb. 1946). The outlines

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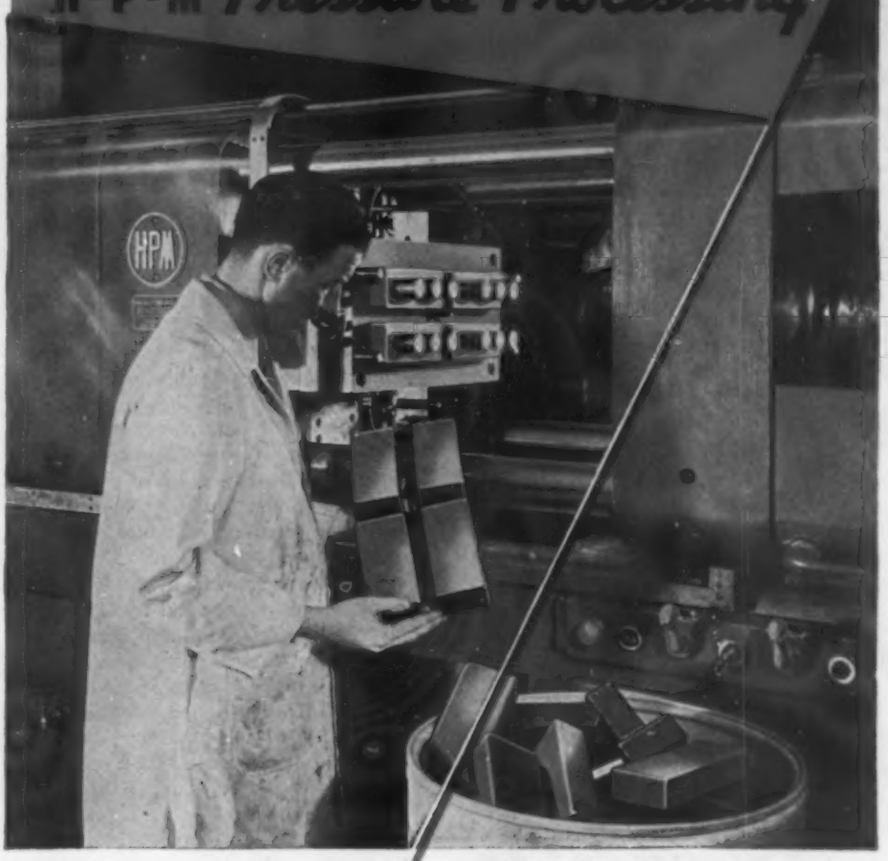

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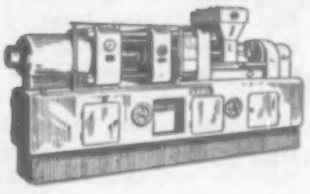

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- ☐ LAMINATING
- ☐ MOLDING (plastics)
- ☐ MOLDING (rubber)
- ☐ RIVETING
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of a theory of elastic loss in cross-linked polymers are developed on the basis of the ideas underlying the theory of dielectric loss of Fuoss and Kirkwood and the three-dimensional network model of rubber structure proposed by James and Guth. The relaxation time distribution function for elastic loss is given in the approximation of free internal rotation of chain segments of the net. The influence of intermolecular hindering torques and network restraints on the relaxation time spectrum is discussed, but explicit calculations are postponed for a later report.

A NEW APPROACH TO THE THEORY OF RELAXING POLYMERIC MEDIA. M. S. Green and A. V. Tobolsky. J. Chem. Phys. *14*, 80–92 (Feb. 1946). A molecular theory of relaxing media is presented which gives an expression for the stress in terms of the strain history. At any given time the strain history produces a distribution in internal strains which for mechanical properties can be characterized by a limited number of internal strain parameters. The second law of thermodynamics is used to define dissipation of energy at constant temperature and explicit expressions for dissipation of energy for any strain history are obtained. Inasmuch as relaxation during straining causes an essential reorganization of structure which is in fact the cause of dissipation, the kinetic theory of elasticity is extended to non-isotropic polymeric networks. A tensor expression for the stress-strain-time relations is thereby developed.

Testing

IMPROVED FALLING SPHERE VISCOMETER FOR USE WITH OPAQUE LIQUIDS. C. A. McDowell and B. Y. Walker. Chem. & Ind. *1945*, 323 (Oct. 20, 1945). A radio frequency oscillator for timing the fall of the steel ball in determining the viscosity of dark liquids is described.

LIGHT SCATTERING OF HIGH POLYMER SOLUTIONS. J. Waser, R. M. Badger and V. Schomaker. J. Chem. Phys. *14*, 43–5 (Jan. 1946). The errors and assumptions concerned in determining the molecular weight distribution of a high polymer by light scattering in solutions at various concentrations are discussed in this article.

DETERMINATION OF TOTAL SOLIDS IN RESIN SOLUTIONS. C. D. McKinney, Jr., E. Turk and W. E. Shaefer. Ind. Eng. Chem., Anal. Ed. *18*, 14–16 (Jan. 1946). Total solids in solutions in heat-stable resins in volatile solvents can be determined rapidly and with an average accuracy of 0.3 percent by first dissolving samples in a suitable nonvolatile, high-boiling solvent and then heating them in vacuo at 100° C. for 20 to 30 min. while they are being agitated. If the proper high-boiling solvent is selected, this general method can be extended to the determination of any nonvolatile stable material in admixture with any volatile substance.

MEASUREMENT OF THERMAL CONDUCTIVITY OF NON-METALLIC SOLIDS. G. L. Hall and I. B. Prettyman. India Rubber World *113*, 222, 235 (Nov. 1945). A transient state method and a steady state method for measuring the thermal conductivity of materials with a low conductivity are herein described.

EVALUATION OF DISPERSIONS BY A NOVEL RHEOLOGICAL METHOD. F. K. Daniel and P. Goldman. Ind. Eng. Chem., Anal. Ed. *18*, 26–31 (Jan. 1946). A technique for the rapid evaluation of dispersions and dispersing agents is presented. The test comprises mixing the dry powder with the dispersing solution, measuring the amount of liquid required to produce two characteristic and reproducible consistencies, and observing the rheological phenomena of the mixture. A good dispersion displays active dilatancy at high powder concentrations. A poor dispersion of flocculate is plastic over a wide range of concentrations and never displays any flow tendencies. A fair dispersion displays passive dilatancy at high concentrations and visible thixotropy at lower powder concentrations.

AN IMPROVED BRITTLE POINT APPARATUS. F. L. Graves. India Rubber World *113*, 521 (Jan. 1946). An improvement on the brittle point apparatus used in A.S.T.M. Method of Test D 746–44 T is described.

Synthetic rubber

THE POLYSULFIDE SYNTHETIC RUBBERS. S. M. Martin. Product Eng. *17*, 65–8 (Jan. 1946). The properties and applications of the polysulfide rubbers are discussed. Some of the applications include paint-spray hose, gaskets, belts, coated fabrics, diaphragms, printing rolls and lacquer rolls. These materials are also available as liquid polymers which are suitable for impregnating, caulking and casting techniques.

SPECIFIC HEATS OF HEVEA, GR-S AND GR-I STOCKS. W. H. Hamill, B. A. Mrowca and R. L. Anthony. Ind. Eng. Chem. *38*, 106–10 (Jan. 1946). Results obtained with a calorimeter, suitable for the rapid determination of specific heats of new polymers, have a precision much better than those obtained by simple mixture methods. Specific heat values are reported for Hevea and GR-S gum and tread stocks, for raw GR-I (Butyl B-1.45), and for a Butyl gum stock. Direct measurement shows that specific heats of compounded stocks can be calculated quite accurately by adding the fractional specific heats of the ingredients and, therefore, do not need to be measured when the specific heat of the raw rubber is known. The specific heat of a standard carbon black (standard Micronex) as it exists in the rubber is found to be 0.18 calorie per gram per degree C., a value identical with the specific heat of graphite. For all rubbers upon which thermodynamic studies were made the observed dependence of stress upon temperature requires that variations in specific heat at constant length with respect to relative length be so small as to affect only the fourth significant figure in the specific heat.

ADVANCES IN RUBBER DURING 1945. E. Chilton. Rubber Age *58*, 467–72, 502 (Jan. 1946). The advances in the rubber industry during 1945 are reviewed.

PROPORTION OF CRYSTALLINE AND AMORPHOUS COMPONENTS IN STRETCHED VULCANIZED RUBBER. A. J. Wildschut. J. Applied Phys. *17*, 51–60 (Jan. 1946). Determinations of the tension-temperature relation of stretched vulcanized rubber were made to provide data about the proportion of crystalline and amorphous components. The amount of crystalline material appears to be 30–32 percent at 600 percent elongation and at 20° C. An expression is derived relating percentage crystalline material and temperature. The results are in close agreement to those of X-ray measurements carried out by Goppel but diverge largely from those obtained by Field. The cause of this difference is not yet quite clear. Stretched vulcanized rubber consists of a predominating amorphous phase with crystallites embedded in it. On stretching, orientation occurs and a systematical addition of secondary valency forces is possible. This is the main cause of the existence of a certain tensile strength. Crystallization, though important as an indication of orientation is more or less an incidental phenomenon. The distance function of the secondary forces may be of equal importance with the orientation.

EFFECT OF MOISTURE ON GR-S. I. C. Rush. Ind. Eng. Chem. *38*, 58–61 (Jan. 1946). Moisture definitely accelerates the rate of cure of GR-S; the increase is a function of the moisture retained at the completion of mixing and not of the total water added to the batch. The normal variation in moisture content of GR-S and carbon black as received are not sufficient to affect the rate of cure of GR-S, since these amounts are lost by evaporation during the mixing. The action of the moisture appears to be confined to the curing stage; it may possibly act as an activator for thiazole-type accelerators with, perhaps, chemical reaction involved. Moisture does not affect physical properties of mill-mixed GR-S stocks, but may result in improved processing characteristics and physical properties in factory operation.

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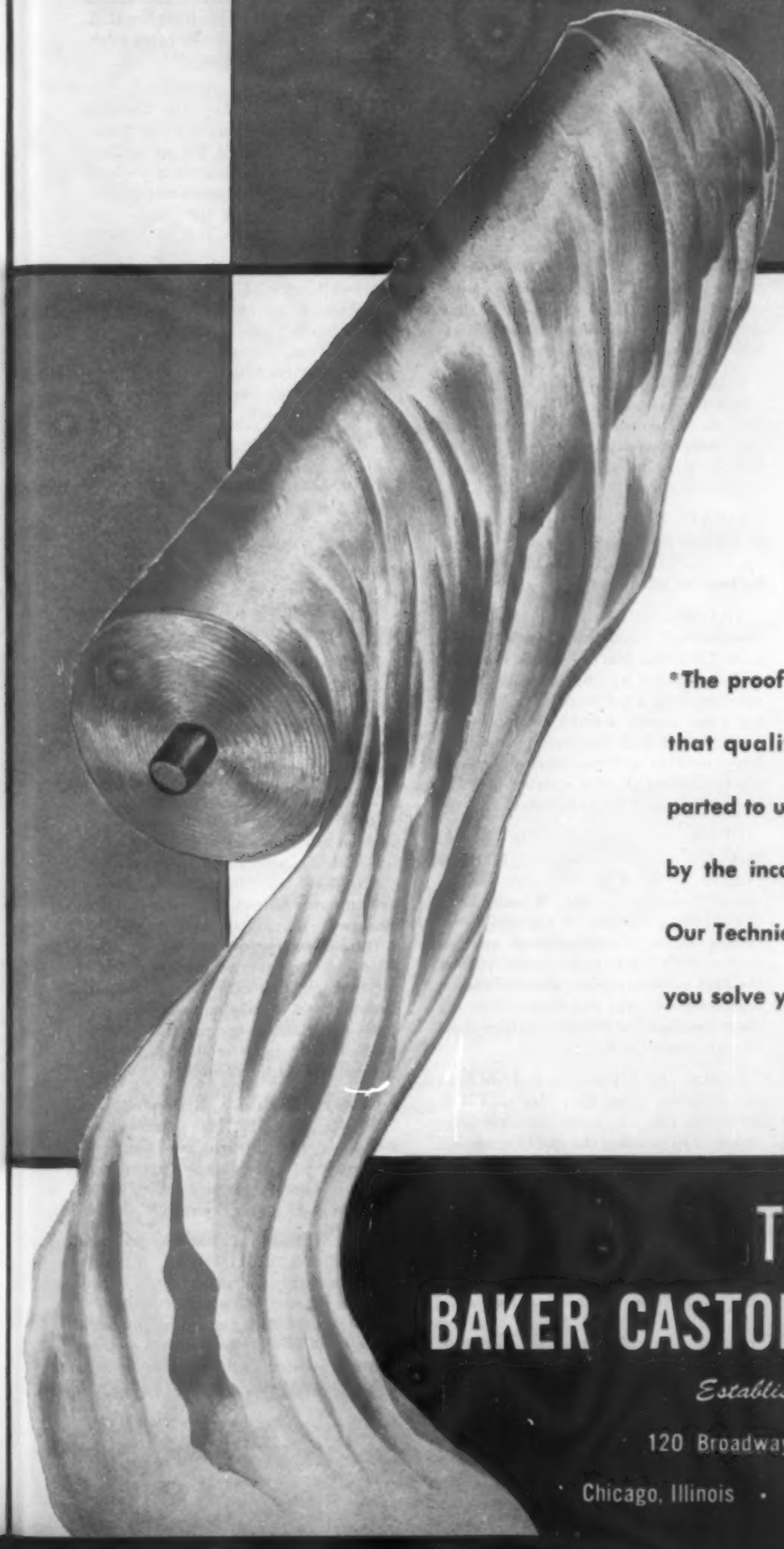

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ADHESIVE. H. C. Brinker and G. B. Gehrenbeck (to Minnesota Mining and Manufacturing Co.). U. S. 2,392,639, Jan. 8. A tacky pressure-sensitive adhesive comprising a rubbery base consisting essentially of a toluol-solvent alkyd resin elastomer reaction product of a polyhydric oil and polybasic acid combined with a tackifier resin containing the abietate radical.

RESINS. F. M. Murdock (to Monsanto Chemical Co.). U. S. 2,392,686, Jan. 8. A casting composition which comprises reacting under alkaline conditions, phenol and aqueous formaldehyde in the presence of polyvinyl alcohol and dehydrating under acid conditions.

RUBBER – PHENOL – ALDEHYDE CONDENSATES. F. J. W. Popham (to British Rubber Producers Research Association). U. S. 2,392,691, Jan. 8. A process for producing rubber–phenol–aldehyde condensates consisting in dispersing rubber in phenol with a metallic oxidizing catalyst such as cobalt naphthenate, oxidizing by passing an oxidizing gas therethrough while heating until the rubber is dissolved, adding formaldehyde and an acid condensing catalyst and boiling until a resin is produced.

MOLDING. W. A. Taylor (to Vidal Corp.). U. S. 2,392,707, Jan. 8. A mandrel comprising in combination a series of wooden contour sections.

INTERPOLYMERS. L. E. Wakeford and D. H. Hewitt. U. S. 2,392,710, Jan. 8. Interpolymers are formed by heating a reaction mixture of styrene and partially polymerized dehydrated castor oil mixed with partially polymerized linseed oil.

SILICONE ELASTOMERS. J. G. E. Wright and C. S. Oliver (to General Electric Co.). U. S. 2,392,713, Jan. 8. A dimethyl silicone elastomer is reclaimed by treating with a small amount of dimethyldihalogenosilane.

COATING. H. L. Gerhart (to Pittsburgh Plate Glass Co.). U. S. 2,392,732, Jan. 8. A coating comprising a solution in an organic solvent of a resinous polymerizate of cyclopentadiene in a glyceride of a fatty acid.

JOINT. A. H. Haberstump (to Murray Corp. of America). U. S. 2,392,734, Jan. 8. Non-metallic elements are joined by applying a thermoplastic material in a thin sheet between the ends of the element to be joined and over the adjacent surface and bonding the material to the ends and adjacent area through heat and pressure.

COPOLYMER. C. J. Mighton (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,392,756, Jan. 8. Polymeric material obtained by polymerizing a halogen-substituted 1,3-butadiene containing not more than 3 halogen atoms in the presence of the di-ester of an aliphatic alpha-unsaturated alpha, beta-dicarboxylic acid and a monohydric unsaturated alcohol containing up to 10 carbon atoms.

COATING. J. D. Ryan (to Libbey-Owens-Ford Glass Co.). U. S. 2,392,768, Jan. 8. A temporary coating for glass comprising isobutylated urea-formaldehyde resin, isobutyl alcohol, toluene, Troluoil and phosphoric acid catalyst.

SAFETY GLASS. J. D. Ryan and G. R. Zolman (to Libbey-Owens-Ford Glass Co.). U. S. 2,392,770, Jan. 8. Method for bending laminated safety glass.

TRANSFORMER. J. K. Webb (to International Standard Electric Corp.). U. S. 2,392,790, Jan. 8. A rigid electrical coil is prepared by impregnating fibrous members with a polymerized resin, winding a coil around a small member, coating the coil with monomer, coating a larger member with monomer and inserting the coated smaller member into the internally coated larger member.

GLASS FIBER STRAND. L. P. Biefeld (to Owens-Corning Fiberglas Corp.). U. S. 2,392,805, Jan. 15. A fibrous strand composed of a multiplicity of glass fibers coated with a material containing dodecyltrichlorosilicane and an amount sufficient to lubricate and protect the fiber surfaces against abrasion and an organo-silicon resin distributed over the fibers in an amount sufficient to bind them into an integral body.

COILS. H. J. Doell (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,392,842, Jan. 15. Coiled structures are prepared by twisting one end of a monofil, formed of an organic polymer, under tension while the other end is held stationary until a coil is formed, continuing the twisting until successive coils are produced and subjecting to a setting treatment.

POLYVINYL CHLORIDE. J. H. McGril (to Imperial Chemical Industries, Ltd.). U. S. 2,392,857, Jan. 15. A sheet material comprising polyvinyl chloride, polymethyl methacrylate and a liquid plasticizer for both polymers.

TEETH. P. W. Lee (to Dentists' Supply Co. of New York). U. S. 2,392,929, Jan. 15. A mold for an artificial tooth is prepared by providing a plaster model of the tooth, disposing molten polyvinyl chloride around the model, subjecting to high pressure, removing model.

COATED PAPER. L. E. Cheyney (to Wingfoot Corp.). U. S. 2,392,972, Jan. 15. Water vapor resistant paper is prepared by coating paper with a polymer of a monomeric substance containing vinyl chloride, treating with a solution of a copolymer of vinylidene chloride and vinyl chloride dissolved in an aromatic hydrocarbon and drying.

FILM. J. F. Vincent (to Wingfoot Corp.). U. S. 2,393,006, Jan. 15. A coated film is prepared by placing rubber hydrochloride film under tension without appreciably stretching and then applying a solution of a benzene soluble copolymer of vinyl chloride and vinylidene chloride and evaporating the solvent while maintaining the film under tension.

THERMOPLASTIC. R. F. Pierce and J. E. Pierce (to Pierce Plastics, Inc.). U. S. 2,393,058, Jan. 15. An organic thermoplastic helicoidal structure is prepared by winding a thermoplastic tape on a rotating mandrel, and heating the wound tape on the mandrel.

LAMINATES. W. Gallay and G. G. Graham (to Honorary Advisory Council for Scientific and Industrial Research). U. S. 2,393,100, Jan. 15. Laminated structures are formed by mixing acetylene black with a synthetic resin to give the mixture direct current resistance without destroying its adhesive properties, incorporating the mixture with the laminate, assembling in a press, applying pressure, and passing an electric current by direct conduction through the adhesive to generate heat and set the assembly.

COATED FABRIC. C. Dreyfus. U. S. 2,393,302, Jan. 22. A fabric coated with a strongly adherent base coating of an organic ester of cellulose upon which is coated a layer of an organic ester of cellulose having a high acyl content.

POLYMERS. J. P. Haworth (to Jasco, Inc.). U. S. 2,393,321, Jan. 22. A composition comprising a linear chain olefinic polymer having a molecular weight of 15,000 to 500,000 and an iodine number of 0.001 to 50 in combination with a curing agent comprising a substance containing a quinonoid nucleus.

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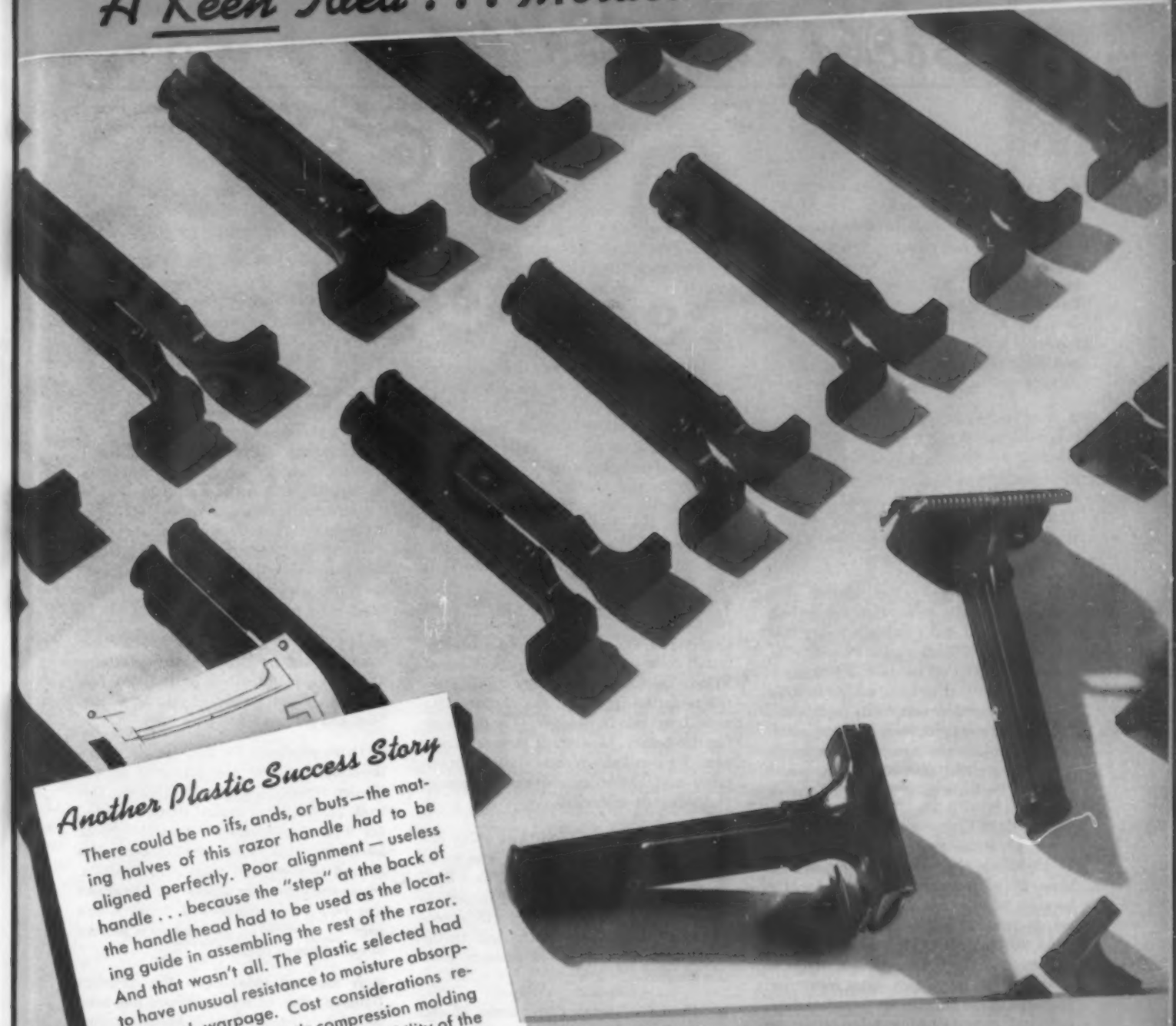

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● Another Engineering Data booklet, this time on center-type and centerless grinding machines and centerless lapping machines, has been just released by Cincinnati Grinders, Inc., Cincinnati 9, Ohio. The bulletin is replete with photos of machines, supplementing dimensional drawings and specifications tables.

● A new technical booklet on Poly-pale resin, a polymeric rosin which is finding use in the paint and varnish industry, has been prepared by Hercules Powder Co., Wilmington, Del. The rosin is said to resist oxidation and to have a high melting point, pale color and wide solubility. It is used in the production of ester gums, gloss oils, spirit varnishes, adhesives, modified maleate and phenolic resins, paper coatings, linoleum and in other industries.

● Reichhold Chemicals, Inc., Detroit 20, Mich., has issued a new illustrated booklet on Plyophen, the company's line of phenolic resins designed primarily for the bonding of fibrous materials, such as paper, canvas, asbestos, Fiberglas, etc., to build up phenolic laminates. The resins are also used for the bonding of woods to produce plywood of high water resistance. Included in the bulletin are technical data, practical manufacturing information on bonding and laminating, and recommendations on the use of the various resins.

● "Infrared parade," has been released by Fostoria Pressed Steel Corp., Fostoria, Ohio, to tell industry what the war has taught on the use of infrared equipment for preheating, baking and drying.

● North American Philips Co., Inc., New York 17, N. Y., has published a bulletin on industrial x-ray equipment for fluoroscopy, radiography, diffraction and spectrometry. Applications such as detection of bent inserts and flaws in plastics pieces by means of radiographs are illustrated.

● Safety wedge grip stamps and interchangeable steel type holders are described in Bulletin WG-462 released by M. E. Cunningham Co., Pittsburgh 19, Pa. The safety steel is said to eliminate mushrooming and spalling, whereas the knurling on the sides of stamps and holders assures positive grip during stamping operations regardless of workmen's greasy fingers or greasy stamps.

● Industrial applications of Vinylite elastomeric compounds are the subject of an illustrated booklet prepared by Bakelite Corp., New York 17, N. Y. These flexible materials which may be molded, extruded, calendered as sheeting and film or coated on cloth are used for such products as storage battery bushings, self-threading valve caps, elevator door bumpers, shock absorbers for truck cabs, insulation for marine cables, chemically resistant hospital sheeting, floor mats for aircraft.

● With the versatility of its products as the theme, Firestone Industrial Products Co., Akron, Ohio, has prepared a booklet in full color on the varied applications of Velon, Velofilm and Veloflex. The plastics materials are shown as upholstery for auto, bus, train or plane seats or furniture for the home; as window screens; wrappings for perishable merchandise; rain apparel and bathroom curtains; luggage; and women's accessories.

● "Fabrics of glass" and their many applications are reviewed in an illustrated booklet issued by Owens-Corning Fiberglas Corp., Toledo 1, Ohio. Of special interest to the plastics industry will be sections on coated glass cloths and textile reinforcements for the low-pressure plastics laminates.

● "Plastic advertising specialties of distinction" are pictured in a 24-page catalog just released by Emeloid Co., Arlington, N. J. Included in the pages are letter openers, celluloid top blotters, rulers, calendar cards, key tags and chains, thermometers and other items.

● A leaflet prepared by Stricker-Brunhuber Co., New York, N. Y., illustrates and describes the service which the company is ready to give in making transparent study models, plastic models for proposed molded parts, experimental work and models in metal and plastics, and molds for plastics.

● The expanded facilities of Hydraulic Machinery, Inc., Dearborn, Mich., are completely outlined in a brochure just issued. Illustrations show designing and engineering, testing and production departments, as well as a number of drilling, facing, milling and pumping units.

● A pictorial bulletin in three colors has been published by Cleveland Worm & Gear Co., Cleveland 4, Ohio, to tell about the applications of worm gear speed reducers to various types of mixing and grinding equipment.

● An almost complete education on the subject of Plexiglas is available in two booklets published by Rohm & Haas Co., Philadelphia 5, Pa. "Looking ahead" presents a good many fundamental facts and applications of the material, whereas the other is a design manual. Included in the latter are sections on optical considerations, light control and piping, fabricating considerations and molded parts. Each recommendation and direction is clarified by means of diagrams.

● The line of pH control instruments manufactured by Bristol Co., Waterbury 91, Conn., is described in Bulletin No. pH1302, which covers electrode assemblies and accessories.

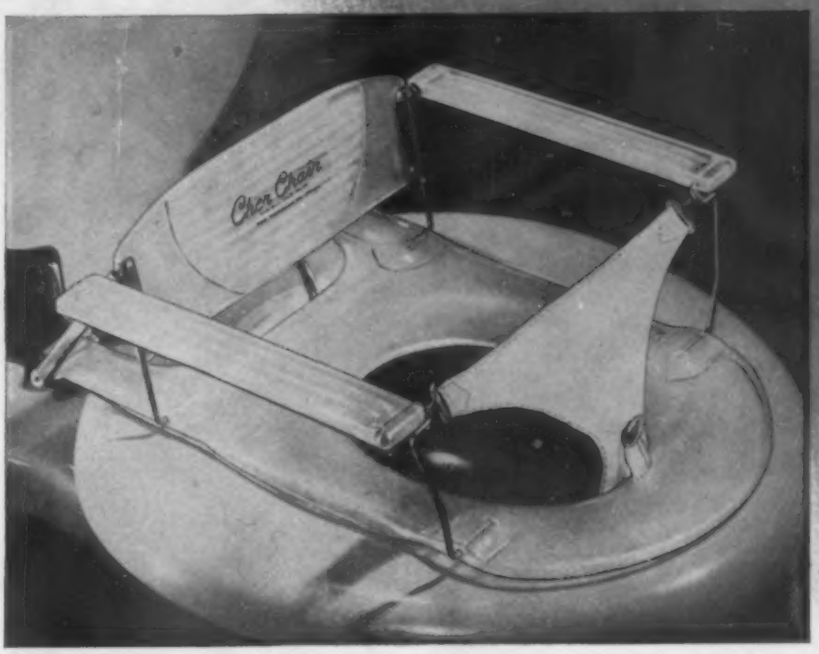
● Drills produced by the "ground-from-the-solid" process are described in the catalog released by Ace Drill Corp., Detroit 27, Mich. Unusual items included are Type "L" drills for plastics, 12-in. Longboy drills, drill blanks, centerless ground reamers and solid carbide drills. These and others are arranged in the digest size booklet in convenient form, a full page in color being devoted to a picture of each type of drill.

● A six-page catalog on the "Perfect Balance" line of soft hammers has been issued by Gregory Tool & Manufacturing Co., Detroit 4, Mich. Covered in the bulletin are 14 different models and 56 different numbers ranging in size (diameter of head) from $^3/_4$ to $2^1/_2$ in. and in weight from 3 oz. to $10^1/_2$ pounds.

● An all-picture booklet with descriptive captions describes the metal fabrication services of the Hungerford Corp., Big Flats, N. Y. Shown is the company's equipment for cutting, forming, arc welding, oxy-acetylene welding and spot welding, in addition to a number of items produced to customers' specifications.

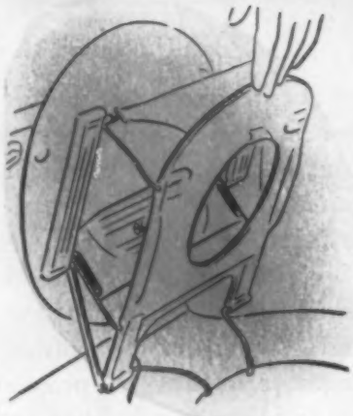
● The Thermex Div., Girdler Corp., Louisville 1, Ky., has released a 24-page bulletin explaining in nontechnical language and pictorially the high-frequency method of heating (*Please turn to page 186*)

GETTING AT THE SEAT OF THE TROUBLE



WITH

Molded Plastics

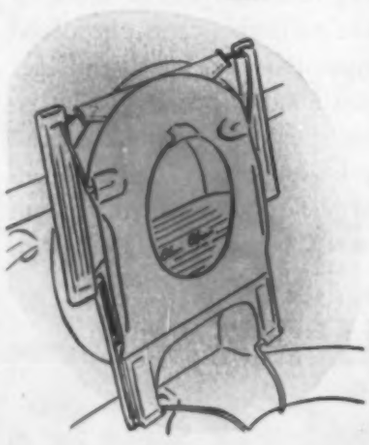


Thousands of parents are going to thank the young father who originated and designed this handy folding toilet seat for children. Easily attached to any standard toilet seat, it provides comfort, convenience, and safety. And it folds back out of the way when not needed . . . only ⅜" thick. Packed in its neat and inconspicuous carrying case, it is particularly appreciated by parents who travel with children.

"Cher-Chair" is a product of The Dunrich Company of Chicago and it has already won enthusiastic acceptance. The arms, back, and seat are molded plastic, of course. Nothing else could be quite so satisfactory. The clear polystyrene material is strong, smooth, safe, and sanitary . . . so easily cleaned . . . so warm . . . so kind to baby's skin. And, with its fittings of stainless steel, it harmonizes attractively with any color scheme.

Yes, "Cher-Chair" is a CMPC job . . . molds, molding and finishing . . . another example of the skill and precision that have won for CMPC a nationwide reputation for quality in plastics molding.

No matter what your product may be, if it calls for molded plastic parts . . . large or small . . . simple or complicated . . . we suggest that you avail yourself of this service and discuss your plans with a CMPC Development Engineer. Your request incurs no obligation.



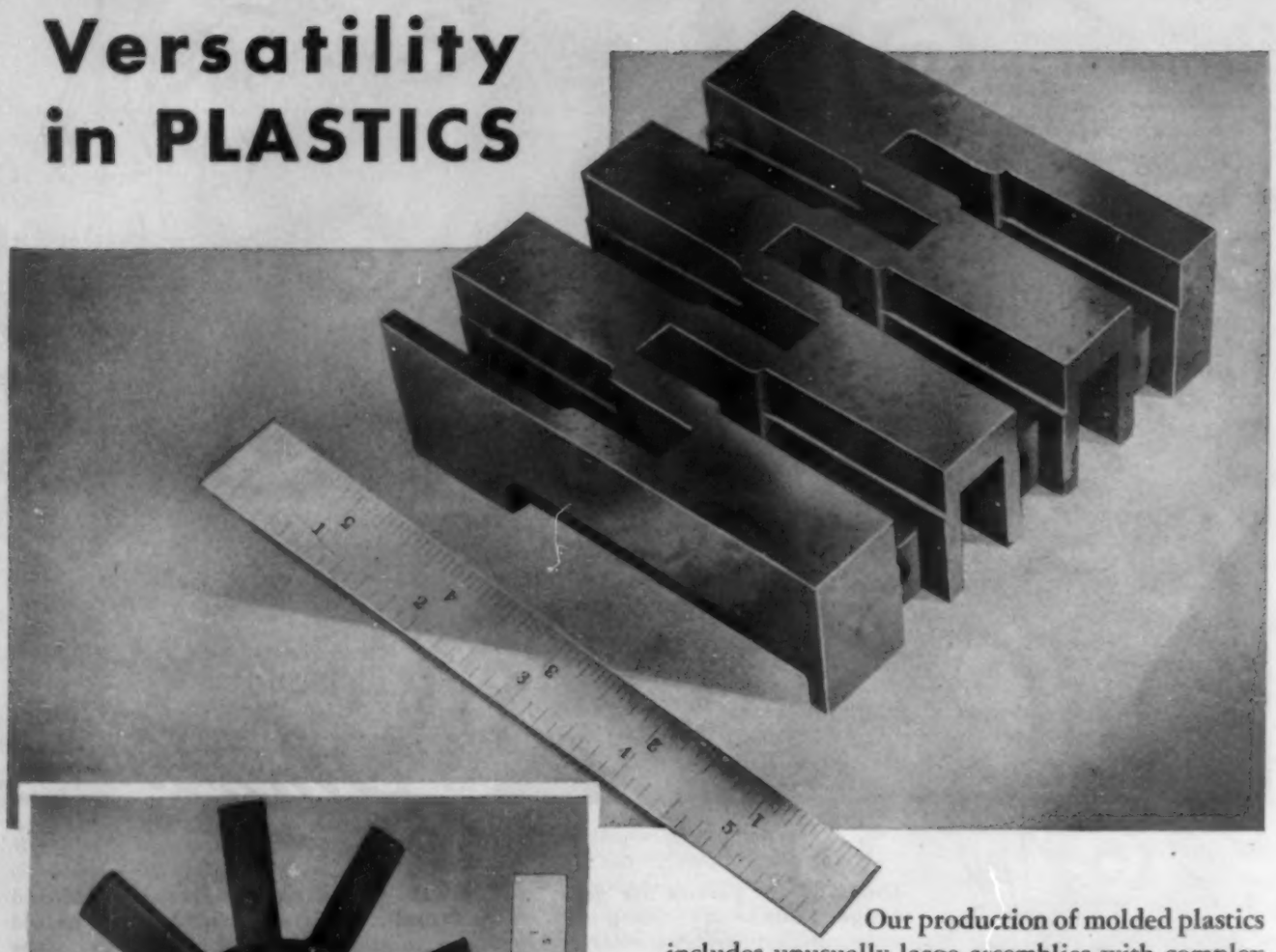
CHICAGO MOLDED PRODUCTS CORPORATION

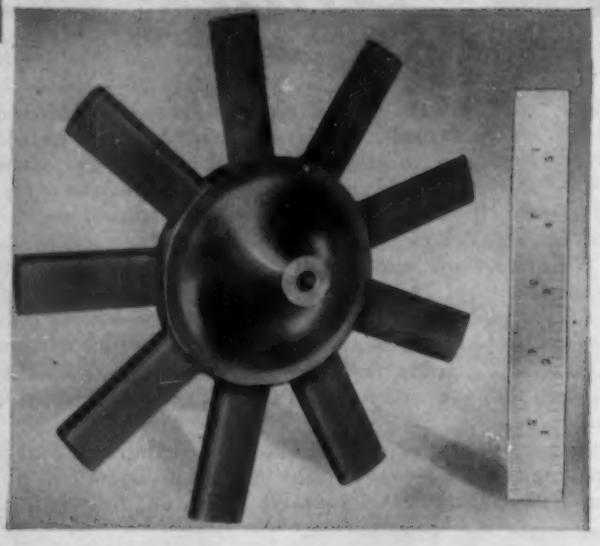
1046 N. Kolmar Ave. Chicago 51, Illinois

Branch offices in principal industrial centers

COMPRESSION AND INJECTION MOLDING OF ALL PLASTIC MATERIALS

Versatility in PLASTICS





Our engineers are trained to consider plastics in relation to your requirements and the product improvement desired.

PM
REG. U.S. PAT. OFF.

Our production of molded plastics includes unusually large assemblies with complex metal inserts and wiring; we also make precision molded parts as illustrated. These widely diversified plastic products and parts may appear to be wholly unrelated, yet both types of work depend upon plastics engineering. The experience of the plastics chemist, the technical skill of the molder, contribute to product improvement thru the proper use of plastics. You may feel that your product requirements are 'different'—that they cannot be solved with plastics. We suggest that you let us consider the possibilities of a plastics application. New plastic materials developed during the war years and improved molding techniques, now available, increase the versatility of plastics. For information on our plastic services, write for Folder File MP 5.

PLASTIC MANUFACTURERS

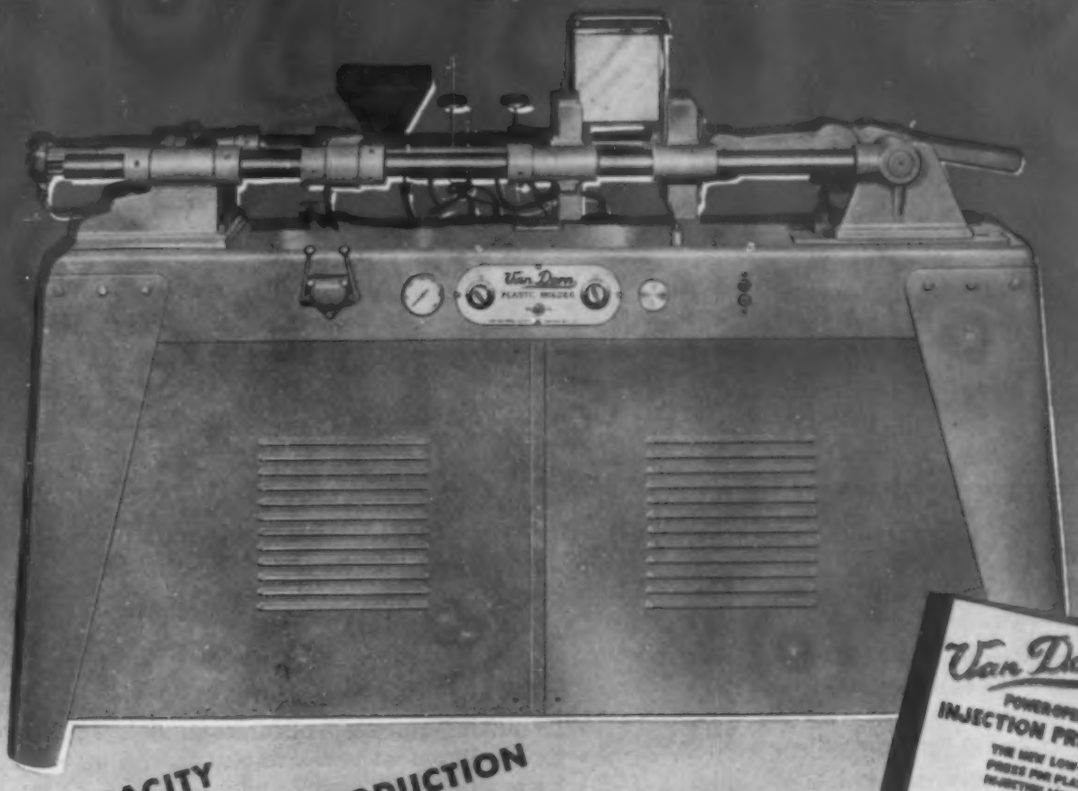
INCORPORATED

STAMFORD, CONNECTICUT

MOLD MAKING • INJECTION & TRANSFER MOLDING • COMPLETE ASSEMBLY

Representatives: DETROIT 2—805-06 New Center Bldg. • LOS ANGELES 35—1440 So. Robertson Blvd.
CANADA—David C. Orrock & Company, 1405 Bishop Street, Montreal

Now— A POWER-OPERATED LOW-COST, PLASTIC INJECTION PRESS ...BY Van Dorn

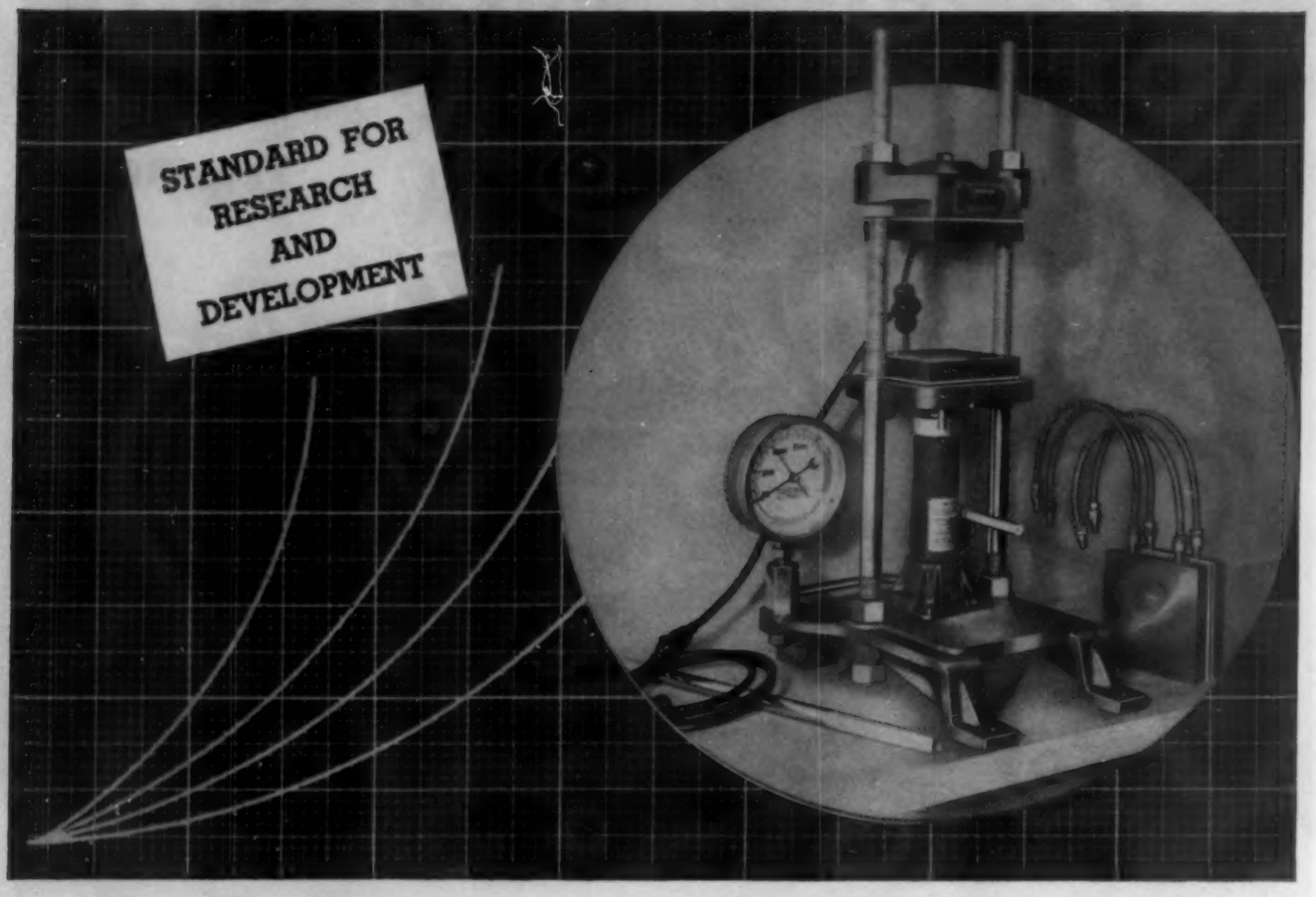


★ 1 OZ. CAPACITY
★ POWERED FOR PRODUCTION
★ AUTOMATIC PARTS EJECTOR
★ AUTOMATIC TEMPERATURE CONTROL
★ LOW COST

Write FOR FREE FOLDER
which illustrates and describes the Van Dorn Plastics Injection Press and its applications.

THE VAN DORN IRON WORKS CO.
2687 EAST 79TH STREET • CLEVELAND 4, OHIO

THE CARVER LABORATORY PRESS



The pattern of Tomorrow is being worked out in Today's laboratory research.

Foremost among the aids in this development is the Carver Laboratory Press. This small, powerful press is just what you need for your research program. Accurately controlled pressures up to 20,000 lbs. are produced quickly and smoothly by hand operated lever. In chemical and plastics research the Carver press performs countless tasks.

•

Additional Carver interchangeable equipment includes swivel bearing plates, cage and filtering equipment, etc. The press and various of the accesories are patented. Send for the latest catalog with full details, applications and prices. Prompt deliveries.

"NOT ACCIDENT—BUT RESEARCH," not hit or miss, but unceasing search to develop new materials and to make old materials serve better. Such is the story of the plastics industry. Aiding in this extensive laboratory research and development during the past 16 years, the Carver Laboratory Press has become familiar and trusted equipment in hundreds of laboratories. Original in design, versatile in service, it is standard

- **for making quick and accurate small-scale pressing tests.**
- **for development, research and instruction work.**
- **for testing single cavity molds.**
- **for preparation of samples.**
- **and even for small-scale production.**

The Carver Laboratory Press is small, compact,

- **has a pressing capacity of 20,000 lbs.**
- **weighs only 125 lbs.**
- **operates under self-contained hydraulic unit, giving any precise variations in pressure that may be desired.**
- **large accurate gauge of finest construction is rigidly mounted on base.**
- **special gauges are available for low pressure work.**

FRED S. CARVER
HYDRAULIC EQUIPMENT
343 HUDSON STREET • NEW YORK 14

GET

POWER plus

WITH

AIRTRONICS*

DUAL PREHEATERS

COMPACTNESS

Never before has so much preheating power and utility been packed into so little space as in the new series of AIRTRONICS Dual Preheaters. For example, the 5 kw Model EK, with all the AIRTRONICS production-speeding features of control and operation, measures only 22" x 26" x 41"—small enough to locate easily wherever it may be needed.

SIMPLE OPERATION

All AIRTRONICS Preheaters have been designed for maximum simplicity of operation. Power output and preheating time are *automatically* controlled. To operate, the molder simply places the charge between the sturdy self-positioning electrodes, closes the hood and presses the proper "start" button.

EASY ADJUSTMENT

Dual power and time controls are mounted on a pivoting panel recessed in the cabinet front. Tilted out, the panel is fully accessible for set-up adjustments. Tilted in and locked, the set-up controls are *completely out of the way*, preventing unauthorized changes.

VERSATILITY

AIRTRONICS Dual Load Selection, Automatic Power Regulation and Wide Range Load Accommodation make possible efficient handling of a greater variety of preheating jobs than ever before. In particular, the dual set-up controls permit running two entirely different loads, alternately, or in any sequence.

5 KW
Model EK

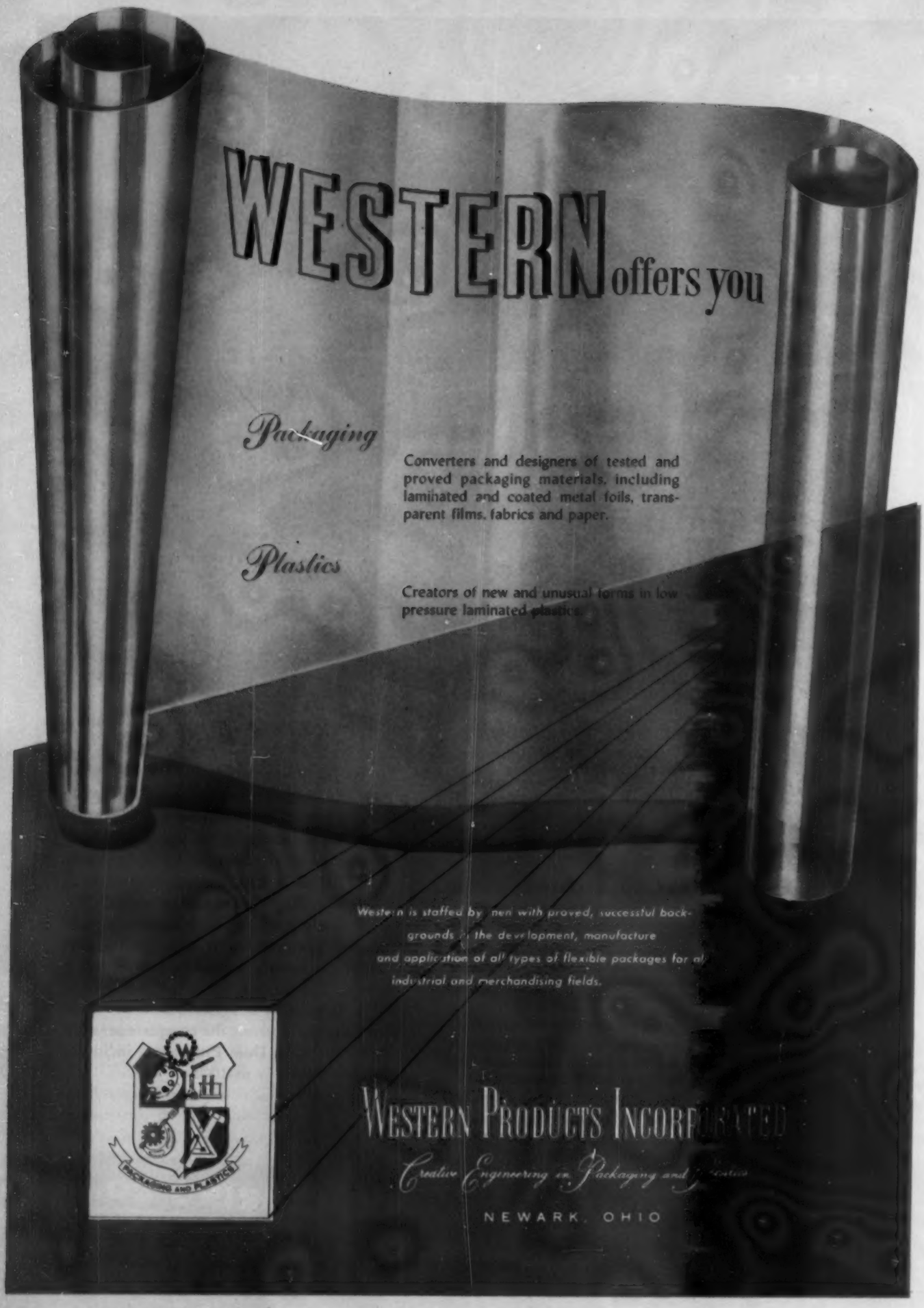
AIRTRONICS Dual Preheaters bring you compact, mobile preheating POWER, plus unequalled simplicity of application, adjustment and operation. Many other unique AIRTRONICS features, such as Automatic Excitation Regulation and powerful Vacuum Cooling of the high-frequency components assure trouble-free performance under the most rigorous operating schedules.

Inquire at any AIRTRONICS office for full details about the complete series of AIRTRONICS Dual Preheaters, including models from 2½ to 10 kw.

*REG. U. S. PAT. OFF

Airtronics MANUFACTURING CO.

CHICAGO ★ 407 S. Dearborn, Zone 5
NEW YORK ★ 24-20 Bridge Plaza South, Long Island City, Zone 1
LOS ANGELES ★ 4536 Cutter Street, Zone 26


WESTERN offers you
Packaging
Converters and designers of tested and proved packaging materials, including laminated and coated metal foils, transparent films, fabrics and paper.
Plastics
Creators of new and unusual forms in low pressure laminated plastics.
Western is staffed by men with proved, successful backgrounds in the development, manufacture and application of all types of flexible packages for all industrial and merchandising fields.
PACKAGING AND PLASTICS
WESTERN PRODUCTS INCORPORATED
Creative Engineering in Packaging and Plastics
NEWARK, OHIO

SAFETY

FIRST:

Away with rejects! Leominster Injection Molder requires only one adjustment of One screw for precise die-alignment, preventing flooding.

SECOND:

Toggle-trouble is eliminated by full-length toggle pin support — and — "Centralshaft" centralized movable plate support assures equalized pressure distribution.

THIRD:

Machine cannot function when EITHER door is open, nor when either of the two independent safety factors becomes inoperative.

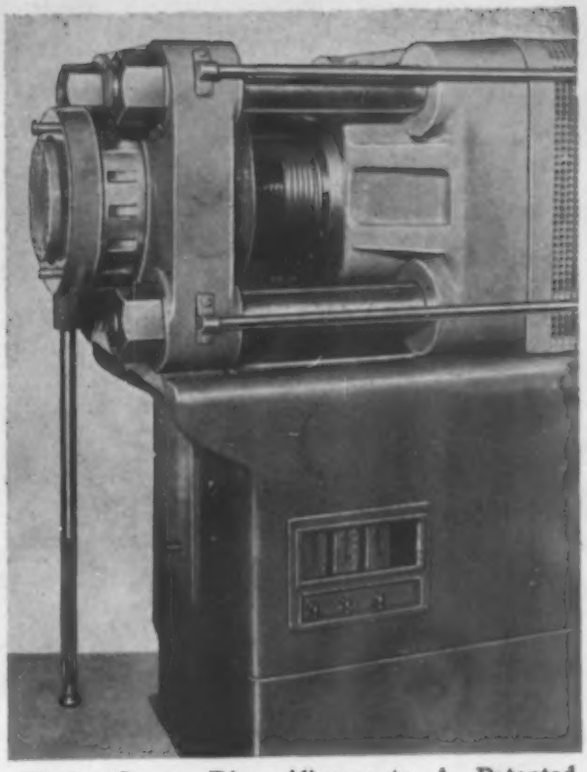
FOURTH:

Ejection parts' erosion, cramping, breakage, are done away with by uniform thrust of the multiple knock-out pin assembly.

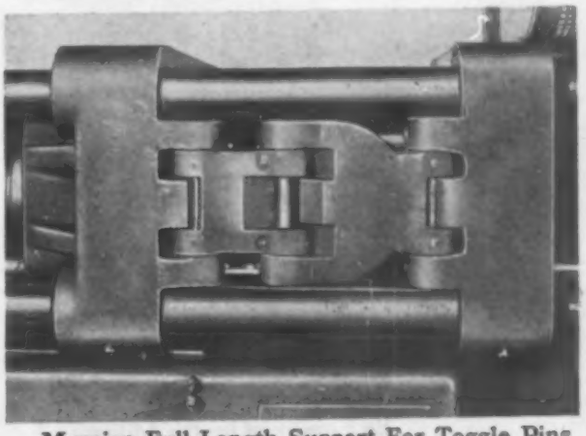
and FIFTH:

An efficient machine assures an efficient operator — each influences the other — for better production — and Leominster Molders are safe, sure certain!

Leominster Injection Molding Machine No. 5, Series 44.



Single Screw Die - Alignment; A Patented Leominster Feature.



Massive Full-Length Support For Toggle Pins

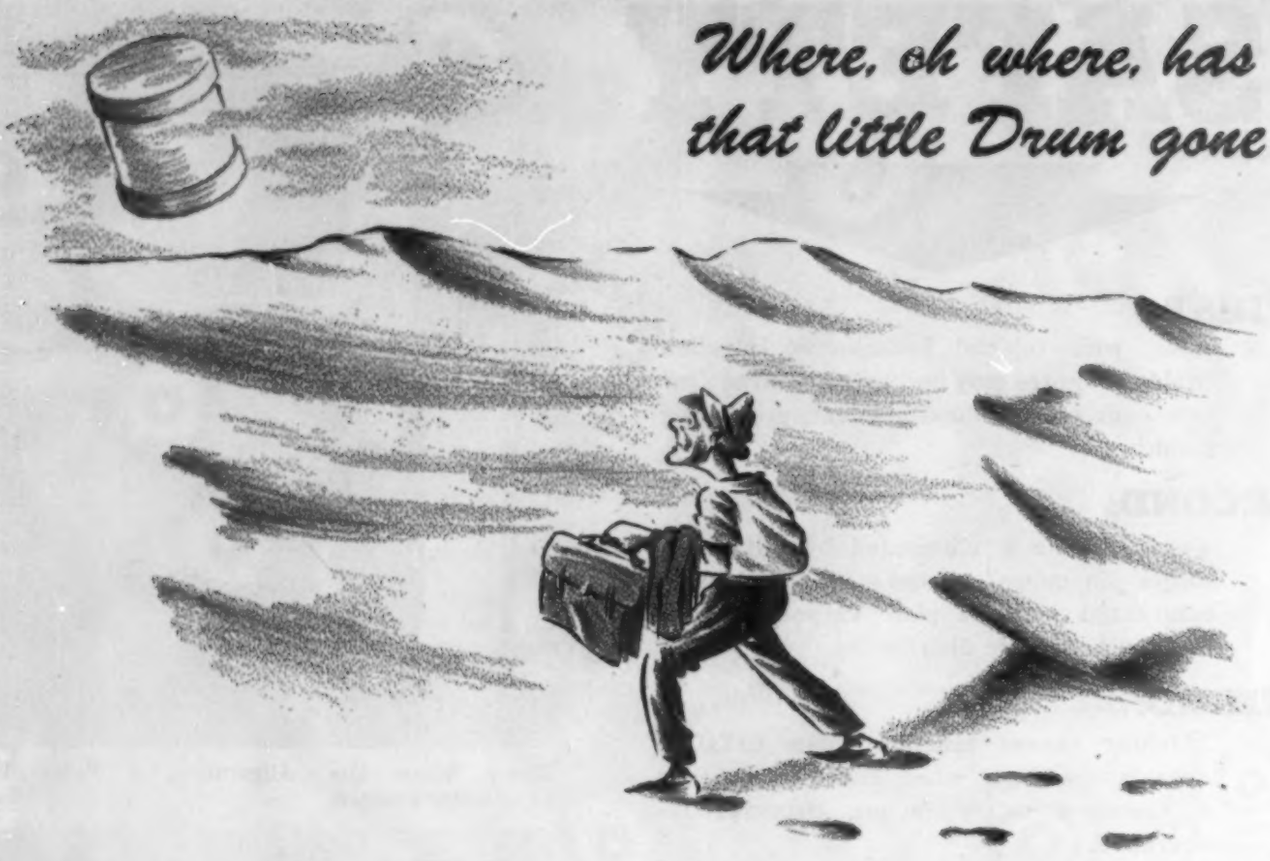
Leominster Injection Molding Machine No. 5, Series 44, termed "the molder with a brain" by plastics experts and operators, is one of a comprehensive line of plastics molding machinery produced by Leominster. May we send you a recent folder describing molds, molders and granulators?

LEOMINSTER TOOL CO., Inc.

LEOMINSTER, MASSACHUSETTS

MANUFACTURERS OF MACHINES, TOOLS AND DIES FOR THE PLASTICS INDUSTRY

Where, oh where, has that little Drum gone?



During War Time Restrictions,
Every Molder Dreamed
Of the Good Days Coming.
Raw Material Plants were
Expanded Many Times,
Chemicals would No Longer
Be Earmarked for the Military.

Huge Trailer Trucks
Would Pull up at our
Door Every Morning.
Once-Haughty Salesmen
Would Come In, Order Book
In Hand, Spot Delivery.
Now—Look at the Reality!

—•—

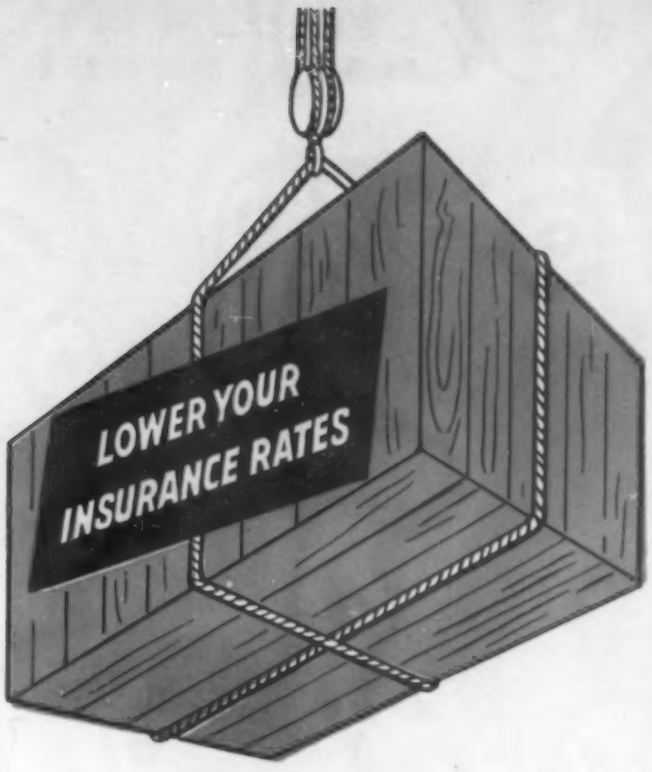
Allocations—Almost Starvation!
Where in Hell IS that Raw Material?

BOONTON MOLDING COMPANY

MOLDERS OF PLASTICS • PHENOLICS • UREAS • THERMOPLASTICS

122 EAST 42nd ST., NEW YORK 17 • MUrray Hill 6-8540

FACTORY—BOONTON, NEW JERSEY



WITH *plastin* LINERS

THERE'S a better chance of securing preferential insurance rates if your product is adequately protected from mildew, rot, rust and corrosion. That's where Plastin can do a job for you!

Plastin heat-sealed bags, barriers and liners, considered the ultimate protection in shipping vital war items, are now available for *your* use. They can probably reduce your insurance rates on everything from ball-bearings to engines—because underwriters know this amazingly effective plastic-protected material not only insures undamaged arrival, but keeps your product "factory fresh" in storage. Write us for the names of the manufacturers and converters who have been so successful with Plastin method II packaging developed for war uses.

pfc
PLASTIC FILM CORPORATION

PLASTIC FILM CORP. • Plant at Plainfield, Conn. • New York Office: 475 Fifth Ave., New York 17, N. Y.

Allied WITH MASS PRODUCTION

Symbol OF A PRODUCTION FORMULA

Pictorial symbols for the combination of chemical ingredients are undoubtedly familiar to you. They represent formulae for products which in turn permit improved manufacturing techniques and make other products possible.

In production operations a formula for improving quality while lowering manufacturing costs is of primary importance. Allied offers that formula in the facilities of four large plants . . . experienced personnel . . . and proven ability to produce the most difficult jobs economically and on time.

To prove to you that we combine our "production ingredients" to meet your needs, may we suggest that you submit prints to us for quotation on any products of the types listed below.

ALLIED PRODUCTS CORPORATION

DEPARTMENT 5-A
4622 LAWTON AVENUE
DETROIT 8, MICHIGAN

ALLIED CORPORATION PRODUCTS — PRECISION • EXPERIENCE • DEPENDABILITY

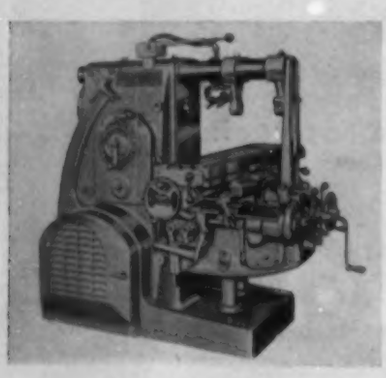
SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • HARDENED AND PRECISION GROUND PARTS • SHEET METAL DIES FROM THE LARGEST TO THE SMALLEST • JIGS • FIXTURES • STEAM-HEATED PLASTIC MOLDS • SPECIAL PRODUCTION TOOLS • R-B INTERCHANGEABLE PUNCHES AND DIES • DIE MAKERS' SUPPLIES

We're in your Backyard
California may seem far away if you live in New York or Philadelphia. But don't dismiss us just because we have settled where the sun shines.
A lot of companies have found that it pays them to come all the way to Los Angeles 22, to get problems solved in plastics that no one else can seem to handle.
Our background is one of solution, not tradition. We initiated a new process, for instance, which produced huge optically accurate acrylic parts for airplanes in jig-time--and even built the jigs!
Recently, new and interesting combinations of decorative cloth and paper laminates have been developed along with their respective adhesives and bonding agents.
We are not so much interested in capitalizing on what we have done as the way that we did it. Problems that call on all of our creative and productive knowledge for their solution are right up our alley. If you have something that seems unsolvable, that is the problem we would like to handle most of all. Of course, we won't turn down the easy ones; and we may even have to say "no" on occasion.
Yours very truly
Dave Swedlow
Dave Swedlow
Call on us at any time.
Swedlow PLASTICS CO.
5527-33 District Blvd.
Los Angeles 22, Calif.

New Machinery and Equipment

● Horizontal and vertical models of the CSM line of knee-type milling machines, available in 20-, 30- and 50-hp. sizes, have been announced by Kearney & Trecker Corp., Milwaukee, Wis. As a result of a thorough analysis of the problems involved in applying carbides to a variety of milling problems, these units were designed so as to have increased rigidity, greater horsepower and a more uniform flow of power to the spindle.

The spindle drive is mounted on the base of the solid-back column and power



is transmitted to the spindle through multiple V-belts and spindle speed selection box. The 16 quick-change speeds from 50 to 1250 r.p.m. are in approximate geometrical progression, as are the 32 quick-change feed rates from $^{3}/_{8}$ to 90 in. per minute. The spindle is provided with a center bearing spindle which is said to reduce deflection eight times.

● To speed milling operations and cut costs the New-Field Machined Parts Co., Chicago 6, Ill., has developed two new extra heavy models of its Universal fly cutter, furnished in 6- and 8-in. diameters, for application on shell end mill arbors. The $1^{3}/_{8}$-in. thick bodies allow ample strength for machining driving slots and counterbores. Like other models, these units use four removable high-speed steel or carbide bits. Since the cutters are adjustable within a certain range, the need for keeping many special cutters on hand is obviated.

● A new and improved Joyro pressure-pull indicator for accurately determining roller pressure-pull during the manufacture of plastics, paper, textiles and other products using rollers in their processing, has been brought out by George Rosales Co., Los Angeles, Calif. With this indicator, which consists of a flat watch spring steel strip connected to a special tensiometer with a reading dial, pressure-pull across the entire length of a set of rollers can be checked by the simple expedient of taking different readings at regularly spaced intervals.

● Wm. A. Force & Co., Brooklyn 8, N. Y., has developed a heavy-duty hot stamping numbering head for insertion in place of the marking die in the head of the standard hot stamping machine. The numbering head has been specially designed for use on plastic parts. A pin, which extends from the machine, can be attached to a link fastened to a stationary portion of the press for automatically advancing the wheels in consecutive order. Special number sequences, including duplicate, triplicate or skip numbering, can also be supplied. All wearing parts are of hardened and special steels to withstand heat and give good wearing ability.

● The inverted Quintuplex Pump with a rated speed of 300 to 450 hp. and a 6-in. stroke, has been designed by Aldrich Pump Co., Allentown, Pa., in answer to a growing public demand for a unit of this size. Plunger diameters range from 2 to $5^{1}/_{4}$ in., working pressures—700 to 5000 p.s.i., capacities—60 to 850 gal. per min.

● The toggle pliers just announced by Knu-Vise, Inc., Detroit, Mich., were designed especially for holding work for welding, drilling, riveting and sub-assembly where operating space is limited and working parts are small. The pliers are available in four styles with a variety of throat gap sizes. The pressure spindle has a slot to facilitate adjustment and it is

claimed that a normal 40-lb. pressure of the hand applied to the handles will multiply to a pressure of 400 lb. at work contact. The pressure pad is so shaped that the rubber cap will remain secure in its fixed position and its almost flat base will not mark the work being held. The units weigh 4 oz. each and have an overall measurement of $4^{3}/_{4}$ by $1^{3}/_{4}$ in. high.

● The addition of a 32-oz. Lester injection molding machine to the company's new line of presses has been announced by Lester-Phoenix, Inc., Cleveland 13, Ohio. Features of the entire line include: 1) improved injection system, in which the vertical heating cylinder has a solid plunger delivering the material over an internally heated streamlined torpedo; 2) rigid one piece, box-type, cast alloy metal frame; 3) metal-to-metal mold locking, comprising a newly designed toggle linkage, with the mold positively supported at all four corners, which is said to speed mold opening and closing—closed, the *shock* load of injection is carried by 4 metal-to-metal supports thru spiral or roller contact of hardened cams on toggle links; 4) enlarged mold height adjusting screw which supports the movable platen both at center and outer perimeter.

(*Please turn to next page*)

PLASTICS MOLDING SERVICE

Available Now...

PRODUCTION CAPACITY at Minneapolis Plastic Molders' plant has been enlarged. Facilities are *available now* for all types of molding work and mold and die making. So, if plastics molding service is a problem in your business, get in touch with MPM quickly. ● *Complete service*—Through every step of the work, MPM is prepared to assume full responsibility for design, mold and die making, die hobbing and compression, injection and transfer molding. Especially today, when delivery schedules are vital, it is important to deal with a single source throughout the entire job. ● *Demonstrated performance*—For more than a decade, the MPM organization has proved its capacity to provide service that combines imagination with experienced technical ability—service that goes beyond mechanical skill. Ask to see how others have profited by this service. And, remember, newly expanded facilities mean this service is available today. Tell Minneapolis Plastic Molders about your requirements now, before production schedules are filled again.

MINNEAPOLIS PLASTIC MOLDERS

INCORPORATED

2300 EAST 31st STREET • MINNEAPOLIS 6, MINN.

Service Beyond Mechanical Skill

● The Electric-Air Control tapping machine manufactured by R. G. Haskins Co., Chicago 12, Ill., claims several new features. A hinged full-length door to

the control chamber permits easy access to all control units, motor, lubricant pump, wiring panel, transformer and electric circuits. The air head, made of cast aluminum with bronze cylinder walls and graphite carbon pistons, prevents rust and corrosion resulting from moisture in the air lines. Use of the unit is said to increase sensitivity in the application of power and to permit extreme accuracy in the control of the depth of the stroke. This machine also offers automatic or controlled cycle of operation as well as a means of synchronizing Electric-Air operated fixtures with the stroke of the tap head. The unit is available in 3 sizes: No. 1-UT handles taps ranging in size from No. 2 to 5/16 in., No. 2-UT handles taps from No. 6 to 5/16 in., and No. 3-UT handles those from No. 10 to 3/8 in. N. F.

● A new unit being marketed by Wyzenbeek & Staff, Chicago 22, Ill., is the Wyco Hy-Speed saw which can be attached to any 1/4-in. electric drill, air drill or flexible shaft, to saw or file metals, wood or plastics. True sawing is said to be assured by a square plunger with takeup for wear. Ordinary hack saw blades and standard 1/4-in. shank machine files are used. Rotating parts are ball-bearing and all are heat-treated.

● The All-Flex ball bearing swivel pipe coupling has been designed by Snyder Sales Corp., Los Angeles 36, Calif., to meet the troublesome problem of conveying fluids under high pressure through a pipe which swivels or rotates a full 360°. A combination of multiple synthetic packings of metallic seals provides protection against leakage at either high or low pressures and is the basis for the swivel coupling. The unit is available in sizes from 1/8 to 1 in. nominal tube size with a variety of threaded and elbow connections to meet almost any given application.

● Buffalo Gasolene Motor Co., Buffalo 13, N. Y., has designed and developed a 20-ton manually controlled hydraulic forming press specially to meet the requirements of those engaged in the production of small parts. The press has a 24-by 36-in. bolster plate, 24-in. gap, 12-in. stroke; weighs approximately 4200 lb.; occupies 38 by 53 in. of floor space; and has an overall height of 87 inches. The hand-operated machine has a 2-lever safety operation. Precision ram speed is accurately controlled as well as the manual reversal. Motor, pumps and tanks are all enclosed in the base of the unit.

● A lightweight portable 12-in. radial saw, which is said to save 25 percent of power saw time on average industrial and production jobs, has been brought out by American Saw Mill Machinery Co., Hackettstown, N. J. The saw, made of light non-rusting magnesium and equipped with 1 1/2-hp. electric motor, weighs approximately 200 lb. and has a 3- by 16-in. crosscut and 20 1/2-in. wide ripping capacity. This saw embodies all the prin-

cipal features of the large size stationary radial saws which are made by the company. An interesting feature is the safety arm which makes for greater speed, safety and accuracy of operation.

● An improved wet belt surfacer for surfacing, grinding and removing stock has been announced by Porter-Cable Machine Co., Syracuse 8, N. Y. Features have been incorporated in the unit which are said to greatly increase its output, offering close tolerance performance and superior finish, and eliminating warpage, discoloration and burrs. The new model has been equipped with a larger capacity recirculating tank for longer operational performance. The coolant, applied with a spray nozzle to work and belt, main-

tains a constantly cool condition which prevents weakening of the structure of plastics, rubber, ceramics, glass and tempered metals.

To conserve space, the machine depth has been reduced to 48 in.; a heavy base gives rigid support to the work table and the automatic feed table. The feed table is designed to assure a tolerance accuracy of 0.005 in., and it controls the in-feed pressure and speed. The steel platen used to back the belt during grinding operations comes in standard size of 9 by 12 in. and the working area of the standard table is 17 1/2 by 11 1/4 inches. Some of the pertinent specifications include: motor speed—1725 r.p.m.; drive units—5 hp. 220/440, vs., 60 cycle, 3 phase; operational speed of cutter 2500, 3550 or 4600 s.f.p.m.

● The factor that sets the new Pistol-Grip heat sealer, manufactured by Sta-Warm Electric Co., Ravenna, Ohio, apart from the firm's other heat-sealing units is the position of the handle which is located above the roller instead of in the usual position at the end of the tool. The unique position of the handle provides for maximum pressure with minimum effort on the operator's part while assuring better control in guiding the sealer. The metal shield and transite baffle prevent injury to the operator.

The electrically heated tool is designed

for sealing of various types of plastic film and sheeting. The heating unit is built for continuous production application and it can be used for sealing straight seams as well as cylindrical, conical or odd-shaped containers or articles.

Johnny, how many times must I tell you that Michigan Molded *doesn't spell plastics?*

TEACHER IS WRONG!

Matter of fact, teacher, young Johnny's just demonstrating his grasp of a mighty pertinent truth! Yes, he's latched onto a bit of knowledge that ought to rate a big A! Or at least a big M — because *Michigan Molded Plastics*, through service that tops the merely adequate and thorough engineering and production skills of highest calibre, has earned the right over a quarter century to stand as a symbol for the name of plastics themselves! Giant versatility and unabashed vigor, coupled with the definite advantage of being small enough to work hand in hand with every customer, have produced and will go on producing outsize results! We invite you to bring your plastic problems to us for intelligent and accurate consideration and recommendation.

MICHIGAN MOLDED PLASTICS, INC.

Dexter, Michigan

News of the Industry

MODERN PLASTICS has just opened a western editorial office and appointed George Drake as Pacific Coast Editor. With this step, MODERN PLASTICS achieves complete news and feature coverage on a nationwide scale. Mr. Drake's offices are located at 427 W. 5th St., Los Angeles, California, with the telephone number, Michigan 9849.

● It has recently been announced that American Development & Engineering Corp., Boston, Mass., has been established to offer to industry, both foreign and domestic, its experience in designing, supervision of construction, and operation of plants for the manufacture of rayon and the production of purified cellulose and cellulose products, and natural or synthetic fibers. Gustavus J. Esselen will head the new organization.

● General Electric Co., Pittsfield, Mass., has developed a new silicone glass laminate which is said to have withstood a week-long test at 250°. The laminate is constructed of layers of glass cloth which are treated with a silicone resin. This new product is expected to open whole new areas in the electrical insulation field.

● It has just been announced that William L. Marshall, Ltd., New York 9, N. Y., is the sole distributor of Parkwood's decorative plastics sheets. These materials will be marketed under the trade name of Marshalite.

● Two new pigments, Whitetex and No. 33, developed particularly for plastic compounding have been announced by Moore and Munger, New York 6, N. Y.

● Monsanto Chemical Co. announced that its Montreal subsidiary, Monsanto (Canada) Ltd., is constructing a polystyrene plant whose output is expected to greatly exceed Canada's prewar requirements for this material.

● Keyes Fibre Co., Waterville, Me., has announced its plans to construct a plant in Hammond, Ind.

● Bray Corp., Pasadena 8, Calif., has perfected a new protective coating for use as a surface cover in darkrooms which is called Vulcabond and has a synthetic rubber and plastic base. It can be applied with a brush, spray-gun or by dipping to wood, metal, rubber, glass and fabrics.

● American Anode, Inc., Akron, Ohio, is building a manufacturing and processing plant in Los Angeles, Calif., which will be equipped to make latex mixes for use in all types of manufactured latex products.

● Polyplastex, Elmhurst, N. Y., has developed Polyplastex releasing agent 595, a liquid mold lubricant which is said to prevent adhesion to all types of non-porous molds. The lubricant is easy to apply, is light in color and dries quickly.

● Goodyear Tire and Rubber Co., Akron, Ohio, has announced the development and production of a new type of Pliofilm for frozen foods. The new material, FF Pliofilm, is said to remain flexible at −20° F. and to possess the same heat-sealing qualities of conventional Pliofilm.

● The corporate name of The Lucidol Corp., Buffalo, N. Y., has been changed to Lucidol Div., Novadel-Agene Corp.

● Decar, Inc., Middleton, Wis., was incorporated early in the year to engage in molding and fabricating of laminates, specializing in contour molding of decorative laminates.

● All electronic power, which is used by Kurz-Kasch, Inc., Dayton, Ohio, to preheat plastic preforms in preparation for molding, will be serviced by the RCA Service Co., Inc., under a new contract which has just been announced.

Personnel changes

● DEWITT THOMPSON, formerly with Mathieson Alkali Works, has joined the sales staff of Heyden Chemical Corp., New York, N. Y. JOHN J. HOWE has become a member of the development dept.

● W. F. SATTERTHWAITE is the new sales manager of International Plastic Corp.'s Metallic Tape Div. in Morristown, N. J.

● LEONARD G. PHILLIPPS has been appointed manager of the Closure Sales Div. of Owens-Illinois Glass Co., Toledo, Ohio.

● LEE T. BORDNER, former district manager for Chicago Molded Products Corp., has resigned his position to establish himself as an independent manufacturers' agent in Los Angeles, Calif. JAMES E. JOHNSTON has been appointed field sales manager in charge of the company's technical representatives.

SAM L. BROUS

● SAM L. BROUS has been named manager of sales development and W. W. SCULL, production manager of plants, for B. F. Goodrich Chemical Co., Cleveland, Ohio. LEONARD M. FREEMAN is the new manager of the recently established works laboratories of B. F. Goodrich Co., Akron, Ohio. HAROLD S. MEYER has been appointed patent counsel, heading the patent dept. of the company; DR. HARLAN L. TRUMBULL, director of synthetic rubber and textile research; and DR. HOWARD E. FRITZ is filling a new post with the title of vice president-research.

● R. GEORGE HARTIG has been transferred from the Central Engineering Dept. of the Pennsylvania Salt Mfg. Co., Philadelphia, Pa., to the Special Chemicals Div. to aid its plastics program.

● A. G. YORK and F. H. STILLMAN have been elected to the board of directors of The Watson-Stillman Co., Roselle, N. J.

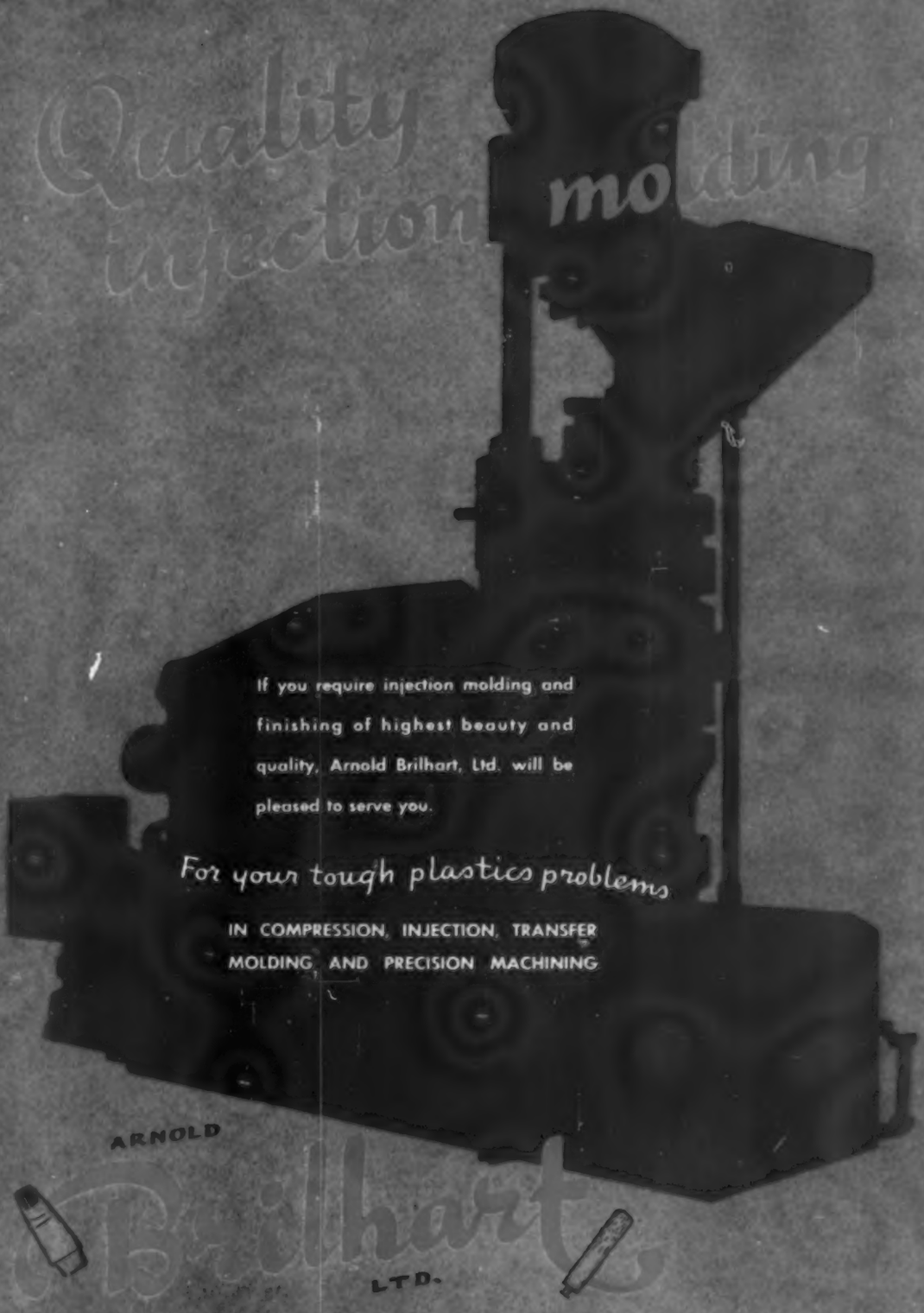
● Plastic Articles Co., New York 19, N. Y., has added MR. E. BENDER to their industrial design department.

● Rogers Paper Mfg. Co., Manchester, Conn., has announced three personnel changes: SAUL M. SILVERSTEIN has been elected president and general manager; SIDNEY A. BROWN, vice-president in charge of production; and ROBERT F. HAWLEY, treasurer and secretary.

● WILLIAM F. NEWTON is manager of research and development for the Columbia Chemical Div. of Pittsburgh Plate Glass Co., Pittsburgh, Pa.

● ROSCOE S. AMRINE has returned to the sales department of Imperial Molded Products Corp., Chicago 12, Ill.

Quality injection molding



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Correlation in strength properties

(*Continued from page 154*) dumbbell specimen than is reported for the dogbone specimen. It is obvious from this discussion that an erroneous impression of the tensile strength of a molded part may be obtained from tests of standard specimens.

The results obtained with the machined dumbbell specimens are in good agreement with the results obtained with the molded dumbbell specimens except for the asbestos-filled material BM-250. Since different batches of molding materials were used for preparing the different specimens, perfect agreement cannot be expected. The slightly higher results obtained by the Bell Telephone Laboratory for BM-3510 may have been caused by the higher rate of loading.

Tensile moduli of elasticity

The tensile moduli of elasticity of the molding materials are given in Table VII. These moduli were obtained with a non-averaging strain gage and consequently are affected by any initial warping of the specimens. The differences between the results obtained for the short-fiber materials with machined and molded specimens are masked by the variability of the results. The differences observed for BM-250, BM-200 and BM-3510 are large enough to be significant, although they are not consistent.

The tensile modulus of elasticity of the asbestos-filled material, BM-250, as determined with molded dumbbell specimens, varied between 1.64×10^6 p.s.i. for a specimen 0.204 in. thick to 2.22×10^6 p.s.i. for a specimen 0.121 in. thick. The moduli of intermediate thicknesses fell in regular sequence between these limits. The moduli of the specimens machined from the flat sheets show only a slight change with thickness and are higher than the moduli of the molded specimens. The other materials did not show this effect.

It is thought that this behavior can be explained as follows: the lengths of the asbestos fibers in BM-250 are short in comparison with the length and width of the reduced section of the molded dumbbell specimen, but are comparable to the thickness. In the central portion of the specimen, away from the edges, the fibers are oriented flatwise in the same way as in molded flat sheets. Along the edges the fibers are oriented parallel to the surface of the molded edge. As the thickness of the molded specimen is decreased the orientation of the fibers approaches the laminar orientation of the flat sheets. The modulus of elasticity correspondingly approaches the modulus obtained for the flat sheets. The magnitude of the change of modulus with thickness for this material is attributed to the large differences between the properties of the asbestos filler and the resin.

The lengths of the fibrous fillers in BM-200 and BM-3510 are short in comparison with the length of the dumbbell specimen but long in comparison with the

Table VII.—Tensile Moduli of Elasticity of Molded Phenolic Materials (Specimens were the dumbbell type specified in Method 1011, Federal Specifications L-P-406a)

Material	*Specimens*			*Tensile secant modulus, 0–2500 p.s.i.*				
	Type	*Thickness*		*No. of tests*	*Average*	*Range*	*S.E.*[a]	*V*[b]
		Average	*Range*					
		in.	*in.*		10^6 *p.s.i.*	10^6 *p.s.i.*	10^6 *p.s.i.*	*%*
BM-45	Molded	0.192	0.160–0.248	6	1.15	1.08–1.27	±0.03	5.8
	Machined	0.137	0.132–0.139	4	1.13	1.05–1.22	±0.04	6.7
	Machined	0.264	0.258–0.267	5	1.07	1.03–1.11	±0.02	3.1
BM-120	Molded	0.172	0.143–0.253	8	1.15	1.08–1.23	±0.02	5.0
	Machined	0.155	0.146–0.160	6	1.10	1.03–1.16	±0.02	5.1
	Machined	0.305	0.303–0.307	5	1.08	1.04–1.11	±0.01	2.9
BM-200	Molded	0.180	0.127–0.282	8	1.31	1.23–1.39	±0.02	4.3
	Machined	0.144	0.140–0.147	5	1.11	1.04–1.15	±0.02	4.0
	Machined	0.252	0.250–0.255	6	1.16	1.11–1.22	±0.02	3.7
BM-250	Molded	0.156	0.121–0.206	6	1.92	1.64–2.22	±0.08	10.5
	Machined	0.134	0.131–0.138	4	2.47	2.22–2.70	±0.11	9.2
	Machined	0.269	0.262–0.275	5	2.29	2.08–2.44	±0.07	6.7
BM-3510	Molded	0.182	0.122–0.226	8	1.27	1.19–1.33	±0.02	4.5
	Machined	0.136	0.131–0.142	6	1.03	0.93–1.15	±0.03	8.0
	Machined	0.266	0.257–0.280	6	1.05	1.00–1.09	±0.01	3.2
BM-6260	Molded	0.169	0.127–0.247	8	0.95	0.83–1.05	±0.03	7.7
	Machined	0.138	0.125–0.146	6	0.97	0.90–1.06	±0.03	6.6
	Machined	0.268	0.257–0.273	6	0.95	0.92–0.98	±0.01	2.7
R-6542	Molded	0.155	0.143–0.235	7	1.17	1.03–1.37	±0.04	9.2
R-6565	Molded	0.224	0.183–0.342	8	0.88	0.81–0.96	±0.02	5.2
R-6905	Molded	0.193	0.124–0.320	8	1.14	0.93–1.27	±0.05	11.5
R-7013	Molded	0.200	0.154–0.257	4	2.46	2.27–2.63	±0.07	6.1

[a] S.E. = standard error of the mean.
[b] V = coefficient of variation.

Sew without thread the **Thermatron** *way*

New Thermatronic method of sealing thermoplastics

Raincoats, shower curtains, toaster covers, food protectors, plastic "patent" leather bags, shoes, play balls and hundreds of other fabricated plastic products are no longer being stitched or sewn with resulting perforations and weakening of the material.

Electronic welding, or the generation of heat by radio frequency power produced by the THERMATRON, is replacing it. Seals are made in seconds to produce a seam stronger than the material itself!

DO YOU KNOW? . . . this dynamic force seals in seconds to produce a seam that is air-tight and water-tight! . . . almost any product fabricated of thermoplastic sheeting which has hitherto been stitched or sealed by resistance heating or adhesives can be Thermatronically sealed — faster, better, and cheaper!

METHOD: Application of radio frequency power supplied by the THERMATRON to films or sheets, generates sufficient heat within the material to cause them to flow together. Surfaces of the material in contact with cold electrodes remain comparatively cool. An immediate weld between layers of material is obtained without adhesives or solvents.

AUTOMATIC OPERATION: All THERMATRON units have full automatic control. Unskilled workmen can be trained to operate even the largest installations.

WHAT SIZE TO USE: THERMATRON 1 KW models will bond two pieces 6 sq. in. in area of .004 Vinylite or a ¼" seal 24 inches long in 15 seconds. The 2½ KW unit will bond two pieces 15 sq. in. in area of .004 Vinylite or a ¼" seal 60 inches long in approximately 15 seconds.

COMPLETE LINE: THERMATRONS are rated in Kilowatt outputs of 1, 2½, 5, 7½, and 15 KW with other models available in 60 — 100 — 125 Kilowatt outputs. Standard ovens and presses make these units completely self-contained and ready-to-use, no complicated installation or operation. Units are completely enclosed, no working parts exposed.

APPLICATION ENGINEERING: Prospective purchasers are invited to make use of the facilities of our testing laboratories. Outline your problem to us. We will test your material in our laboratory in collaboration with your own engineers.

... Inquire Now! Product fabricators are rapidly adopting the THERMATRON industrial electronic sealers as the answer to high speed production of innumerable new plastic articles.

THERMATRON dielectric heaters, completely self-contained and ready-to-use are also available to molders for pre-heating rubber and plastic preforms, and for laboratory, wood glueing and general purpose use.

Write for free copy of the new bulletin "Electronic heating with THERMATRON", describing applications and advantages of THERMATRON.

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Table VIII.—Flexural Moduli of Elasticity of Molded Phenolic Materials

Material	*Type of specimen*	*Direction of testing*[a]	*Depth, average*	*Width, average*	*Span-depth ratio*	*No. of tests*	*Initial flexural modulus of elasticity*		*Moduli of elasticity*[b] *reported by manufacturer*
							Average	*Range*	
			in.	*in.*			*10^6 p.s.i.*	*10^6 p.s.i.*	*10^6 p.s.i.*
BM-45	Molded bar	Flatwise	0.475	0.499	8	2	0.94	0.939–0.948	0.89
	Molded bar	Edgewise	0.499	0.478	8	2	1.00	1.00 –1.01	..
	1/8 in. flat sheet	Flatwise	0.139	0.92	16	6	1.04	0.98 –1.07	..
	1/8 in. flat sheet	Flatwise	0.140	0.50	16	6	1.01	0.87 –1.08	..
	1/4 in. flat sheet	Flatwise	0.264	0.93	16	6	1.02	1.00 –1.04	..
	1/4 in. flat sheet	Flatwise	0.265	0.50	16	6	1.00	0.96 –1.04	..
BM-120	Molded bar	Flatwise	0.476	0.499	8	2	0.93	0.929–0.937	1.00
	Molded bar	Edgewise	0.499	0.478	8	2	0.93	0.926–0.942	..
BM-200	Molded bar	Flatwise	0.487	0.501	8	2	1.10	1.09 –1.11	1.00
	Molded bar	Edgewise	0.501	0.485	8	2	1.22	1.20 –1.24	..
BM-250	Molded bar	Flatwise	0.478	0.502	8	2	2.11	2.11 –2.11	1.00[c]
	Molded bar	Edgewise	0.502	0.476	8	2	2.36	2.35 –2.37	..
BM-3510	Molded bar	Flatwise	0.502	0.502	8	2	1.10	1.08 –1.13	1.00
	Molded bar	Edgewise	0.502	0.491	8	2	1.25	1.22 –1.27	..
BM-6260	Molded bar	Flatwise	0.490	0.501	8	2	0.88	0.857–0.904	1.00
	Molded bar	Edgewise	0.500	0.488	8	2	0.91	0.908–0.910	..

[a] Flatwise = depth of beam in direction of ram motion. Edgewise = depth of beam perpendicular to ram motion.
[b] Data from Bakelite Technical Data Book.
[c] Data sheet published January 30, 1942.

width and thickness. Because of these relative dimensions the fibers are oriented along the length of the specimen and cause the moduli of the molded specimens to be higher than those of the specimens machined from flat sheets. The fibers in specimens cut from flat sheets are oriented in the plane of the sheet, but have a random orientation along the length of the specimens.

Flexural moduli of elasticity

Data for modulus of elasticity in flexure are reported in Table VIII. These moduli agree fairly well with the tensile moduli reported in Table VII. The moduli determined on 1/2 by 1/2 by 5 in. molded bars are affected by the direction of testing with reference to the direction of application of the molding pressure. The orientation of the fibers in molded bars is shown in Fig. 4. Since the fibers along the edges can be oriented both parallel to molded edge and perpendicular to the direction of the ram motion, these surface fibers are most highly oriented. Higher results are obtained in edgewise tests when the depth of the beam is taken perpendicular to the direction of ram motion when the most highly oriented fibers are located in the tension and compressive faces of the beam. The effect is greater for materials containing long fibers (large bulk factors), as is shown in Fig. 9.

Books and booklets

(*Continued from page 166*) dielectrics for manufacturing plastics, plywood, textiles, etc. The five-color booklet discusses the age of electronics, how high-frequency equipment works and what it accomplishes, as well as the range of applications.

● Two pamphlets on stainless steel corrosion-resistant valves have been received from Alloy Steel Products Co., Inc., Linden, N. J. One illustrates how the valves are used in industry; the other (Technical Bulletin No. 2) presents data for engineers.

● In a booklet entitled "Your New Laboratory, Sir!" Behr-Manning Corp., Troy, N. Y., announces its new centrally located, branch office demonstration laboratories for customer use in pre-testing their grinding, sanding and finishing tool-ups on standard equipment without disturbing their plant production schedules. Cities in which these laboratories are located include St. Louis, Chicago, Boston, Detroit, Cleveland and Troy.

● An interesting little booklet prepared by Paul O. Abbe, Inc., Little Falls, N. J., recounts half a century of the company's service in the field of grindings and mixings. Sketches show some of the mills in use fifty years ago.

● Weldco covered rolls are described in a two-color brochure (R-45) prepared by Youngstown Welding & Engineering Co., Youngstown, Ohio, which shows how covers are put on and how the rolls can be used in manufacturing Cellophane, vulcanized fibre and rayon and in other industries as well.

● "How to buy surplus machine tools" is the subject of a booklet based on the experiences of buyers and War Assets Corp. executives and published by the National Machine Tool Builders' Association, Cleveland 6, Ohio. Complete data is given on *how*, *where* and *when*, including a list of addresses and phone numbers of surplus sales and information offices throughout the United States.

● Tube-Kote, Inc., Houston 4, Texas, has prepared a bulletin on plastics coatings for corrosion resistance. Both thermosetting and thermoplastic applications to metal, wood and concrete surfaces are included. Most of the data in the booklet are technical in nature.

● Selected fabric samples for the plastics industry made in the 18 mills of Wellington Sears Co., New York 13, N. Y., are shown in a sample book recently issued.

WHEN THE ESSENTIAL QUALITY IS

LIGHT WEIGHT

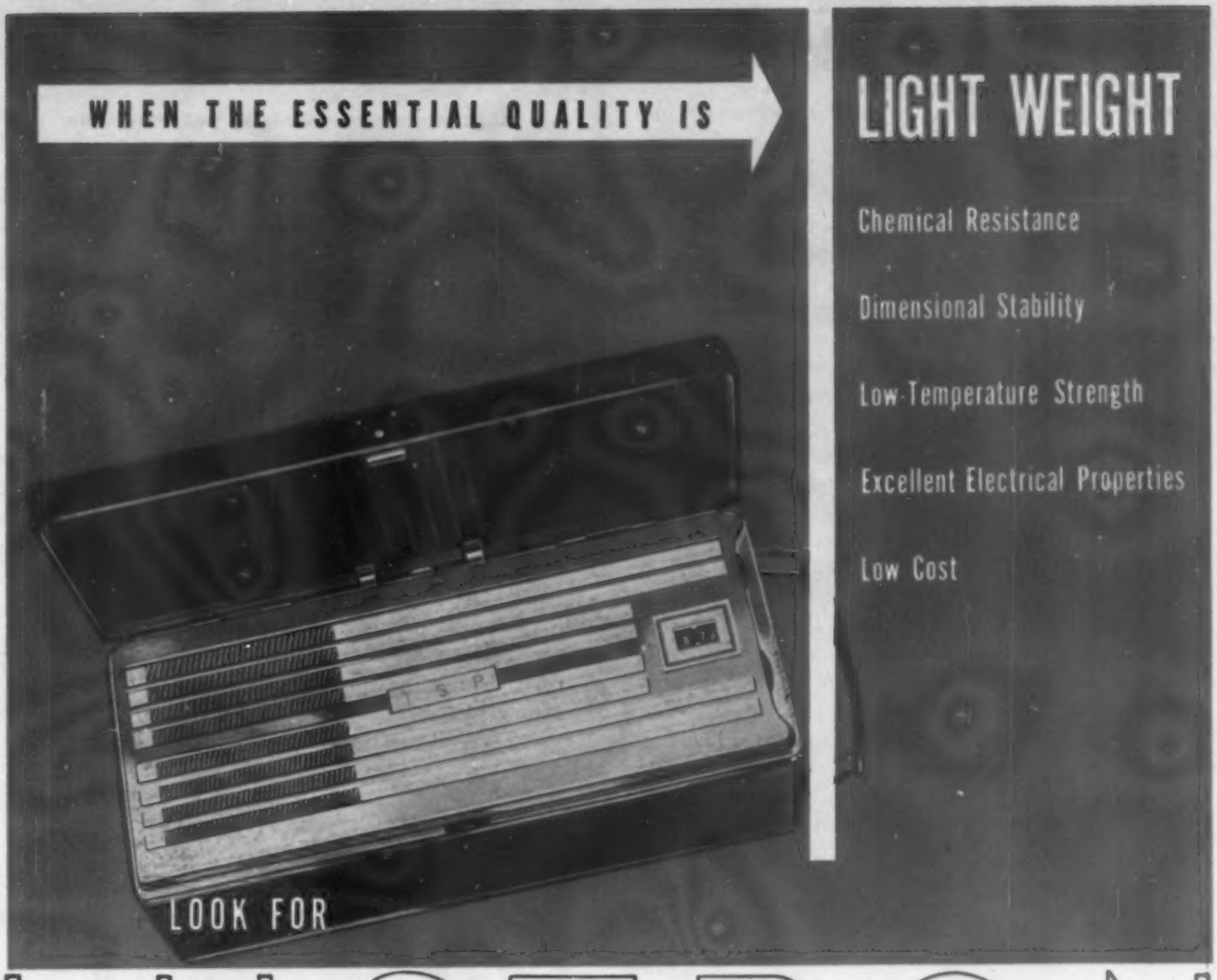
Chemical Resistance

Dimensional Stability

Low-Temperature Strength

Excellent Electrical Properties

Low Cost



LOOK FOR

LUSTRON

Light as a handbag, handsome as it is handy, this personal radio owes much of its practical appeal to the decorative covers of Lustron.

First of all, Lustron, Monsanto's polystyrene, is *light in weight*, as much as one-tenth the weight of alternative materials, 17% to 25% lighter than many other thermoplastics and, of course, much lighter than any metal, including magnesium.

Other functional superiorities in this application include Lustron's excellent electrical properties; there is no possible impairment of the highly efficient loop antennae concealed in the Lustron cover. (The coil forms in this radio are also of Lustron.) Lustron, moreover, is strong, dimensionally stable, its acoustical properties are correct for the use, and it is low in material cost, low in production cost.

Add these to Lustron's jewel-like beauty, its wide color range . . . and you understand why once again the designers specified Lustron.

Complete technical data on Lustron and counsel on adapting the versatile plastic to your needs are yours for the asking. Write, wire or phone: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile family of Monsanto Plastics includes: Lustron® polystyrenes • Cerex® heat resistant thermoplastics • Vinyl acetals Nitron® cellulose nitrates • Fibestos® cellulose acetates • Thalid® for impression molding Resinox® phenolics • Resimene® melamines. Forms in which they are supplied include: Sheets • Rods Tubes • Molding Compounds • Industrial Resins Coating Compounds • Vuepak® rigid, transparent packaging materials.

®Reg. U. S. Pat. Off.

MONSANTO PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

Polymerization of ethylene

(*Continued from page 145*) pressors in permanent use because the acid number constantly increased during operation due to the high compression temperatures and there was danger that the compressors might be corroded. We soon changed to a new synthetic lubricating oil made with trimethylolpropane and ethylene oxide. This oil, marketed under the designation LK 2200, stood up well in the middle range compressor.

In the experiments with larger machinery (250 normal m.³/hr.) it became evident that, especially at pressures of more than 1000 atmospheres, a perfect oil separation could not be achieved in spite of various modifications of the 8-liter separator. We therefore, had to lubricate with glycerol or methylglycerol (butanetriol). Both of these lubricating materials can be separated without difficulty because of their insolubility in ethylene and their high density.

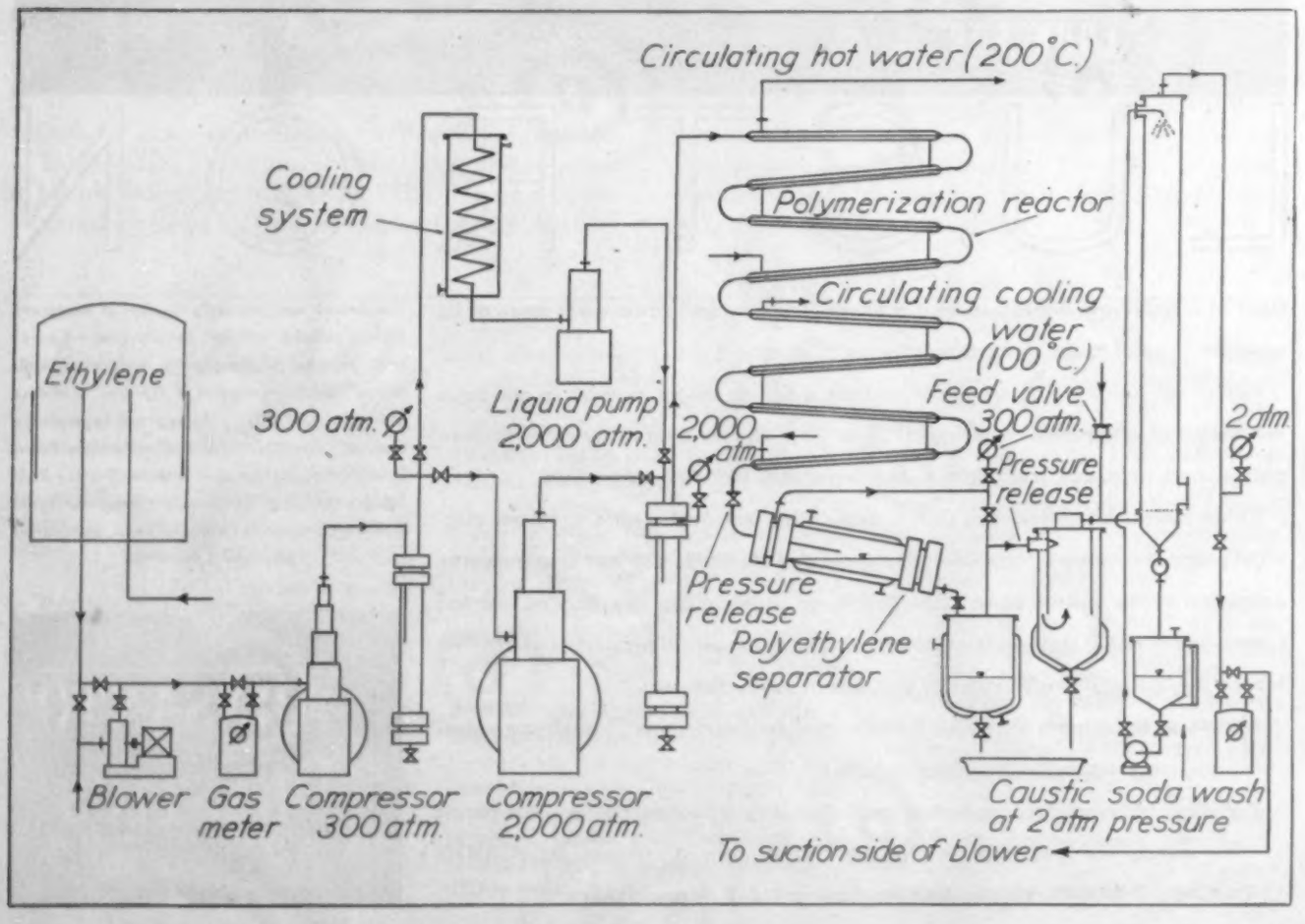
The pump for compression of liquefied ethylene was constructed to be self-lubricating. Because this construction did not work, the necessary lubricating oil was added, at the suction side of the pump by means of a Bosch oiler, to the liquid ethylene and together they were brought to 1000 to 2000 atmospheres. The wetting of the plunger with lubricating oil achieved in this way serves to maintain the tightness of the packing.

High molecular weight polyethylene

A flow diagram of the plant is shown in Fig. 8. Ethylene is fed by means of a blower from a gas holder to the suction side of a compressor. This compressor connected to a buffer tank compresses the gas to 300 atmospheres. This ethylene at 300 atmospheres is compressed to 1100 atmospheres in a booster compressor and fed into the polymerization reactor (Fig. 6). But it can also be liquefied by refrigeration and pumped to 4000 atmospheres with a liquid pump.

In the first part of the polymerization reactor, which consists of 10-mm. tubes, the reaction is started by means of heat supplied by circulating water at 200° C. through jackets around the tubes, and then concluded in 16-mm. tubes cooled with water at 100° C. Tubes of 10-mm. bore used for polymerization get clogged after some time. After the reaction, the polyethylene-ethylene mixture is released through a step-release valve into a separator at 200 atmospheres. The polyethylene, which at this pressure still contains dissolved gases, is further released into a degassing vessel and removed from it as a liquid. The gas which was not poly-

8—Flow diagram of plant for the production of polyethylene at 2000 atmospheres pressure



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merized moves continuously through a pressure release valve into another separator where entrapped wax particles are removed.

Oxygen to replace that which was used up during the reaction is added to the unpolymerized gases and well mixed with them in a caustic soda bath. At the same time, the caustic soda bath removes aldehydes which were formed during the reaction, especially formaldehyde, and traces of oil-type products. In order to avoid the need of a drying tower, an overflow valve keeps the caustic soda bath constantly under a pressure of 1.5 atmospheres to keep down the moisture content of the gases. The residual gases are brought to the suction side of the blower and with the addition of fresh gas are fed back to the polymerization process.

The plant has been working without any disturbances. Its capacity is 550 kg. per day with an effective yield based on ethylene of 93 to 96 percent. A single pass of the gases will yield 8 to 15 percent polyethylene.

Effect of pressure, temperature, oxygen, etc.

The quality of the products as indicated by molecular weight and elasticity (number of folds) can be increased at the expense of the yield with higher operating pressure at the lowest possible polymerization temperature and low oxygen content of the ethylene. However, the oxygen content cannot be dropped below a certain amount because cross-linked polyethylenes will be formed. These have no definite melting point at 110 to 115° C. but a softening point above 115° C. These cross-linked polyethylenes are also obtained when ethylene is polymerized without oxygen.

According to our experience so far, the rate of flow inside the reactor should not be allowed to go below 20 cm./sec., because the products of high molecular weight decompose when local overheating occurs. Such products with poor elasticity (number of folds 2 to 5) have been marketed under the name of Lupolen S.

Completely unelastic, hard and tough polyethylenes are obtained at 700 to 800 atmospheres pressure, 250 to 300° C., and an oxygen content of 0.5 percent. These products differ from I. G. Wax A (Lupolen N) in that the latter contains small amounts of soft waxes and traces of benzoic acid.

Experimental tests at 500 to 600 atmospheres and polymerization temperatures over 300° C. with ethylene having an oxygen content of 1 to 2 percent resulted in vaseline-like products.

The oxygen content of the polyethylenes varies according to the degree of polymerization between 0.2 and 0.4 percent.

The folding endurance of the products obtained so far from the 10 tons/mo. plant is 45, corresponding to an average molecular weight of 9000. According to the preliminary tests, it will be possible to raise the molecular weight considerably without difficulty as soon as the pumps and compressors can be operated at 1500 to 2000 atmospheres in continuous production.

Lupolen H is almost insoluble in all solvents. Only at 70° C. is there appreciable solubility in benzene,

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WITH COLORFUL NEW PLASTICS!

Emeloid—long a pioneer in the production of colorful plastic kitchen accessories—again steps to the fore with a smart, modern dish drain and waste basket. The result of a new molding technique developed by Emeloid, these new kitchen accessories are attractive, washable, durable and economical. Here's additional proof that Emeloid molds for practicality—for sales—for what the consumer wants.

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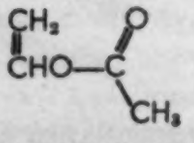
(STABILIZED)



Boiling Range 71.8° to 73°C.

Vinyl Acetate can be polymerized to form resins with exceptional bonding qualities for wood, glass, metal and fibre

Containers:—
410 lb. drums; 62,500 lb. tank cars
For further information write to:

xylene and carbon tetrachloride. It is not affected by acids, alkalies and ultraviolet light. Due to its outstanding electric properties it is especially used in the cable industry. When Lupolen H is added to Oppanol B 200 (polyisobutylene), a product is obtained which can be easily calendared into a film, the tearing strength of which is double that of Oppanol B 200.

Safety devices and measuring instruments

The following additional equipment has been employed in the polyethylene plant:

1. Safety valves up to 4000 atmospheres which act in case of excess pressure.
2. Contact manometer up to 3000 atmospheres will shut off compressors in case of excess pressure.
3. Safety device against explosion. On the advice of Dr. Weissweiler, a safety device against explosion was installed between the 2000-atmosphere tank and the polymerization system. This device is to prevent the wave of explosion from reaching the compressors, in case decompositions occur. The device consists of a pipe, 1 meter long and 30 mm. in diameter, which is packed as closely as possible with steel (V_2A) shavings. The large surface of the packing material effects a momentary drainage of the high explosion temperatures and stops the decomposition of the ethylene.
4. Instrument to meter the oxygen into the ethylene continuously. The instrument, developed by Dr. Weidner, is based on the ready oxidation of nitric oxide (NO) to nitrogen dioxide (NO_2). The turbidity of the gas, changing according to the oxygen content of the ethylene, is seen in a tube of 2 selenium cells and serves as a measure of oxygen content of the ethylene.
5. Thermocouples for use at 4000 atmospheres, installed in the polymerization tubes, to control the course of the polymerization reaction.

Summary

An experimental process for continuous polymerization of ethylene in methanol at 200 atmospheres was improved. A 10 tons/mo. pilot plant for production of I. G. Wax A (Lupolen N) was built in Zweckel. The plant is working without difficulties and has a capacity of 615 kg./day. I. G. Wax A has proved to be useful as a casting material for the cable industry, as a compounding agent for use with Oppanol B 200 (polyisobutylene) and for wax polishes and shoe creams.

The process to polymerize ethylene in continuous operation on a semi-commercial scale at 1000 to 2000 atmospheres was further improved and a 10 tons/mo. plant was built in Ludwigshafen. The plant is working perfectly and has a capacity of 550 kg. per day. Lupolen H has been found useful in the cable industry on account of its good electrical properties and elasticity.

A less elastic Lupolen was prepared at 900 atmospheres which is marketed under the name Lupolen S.

Ethylene of 98 percent purity, as produced in several I. G. plants, can be used for the polymerization without further purification.

The effective yield based on ethylene is 93 to 96 percent.

"I wish cooking were *that* simple!"

THAT'S what Dottie said one day when she took a trip through her uncle Jim's plastics factory. She was properly impressed by everything, but what really caught her eye was a THERMEX high frequency heating unit with the drawer heating compartment.

The THERMEX operator simply puts the preforms into the drawer. Closing the drawer automatically turns on the high frequency power which creates heat uniformly throughout the preforms, surface and center. In a minute or so, when the required temperature has been reached, the high frequency energy automatically shuts off and the preforms are ready for the press.

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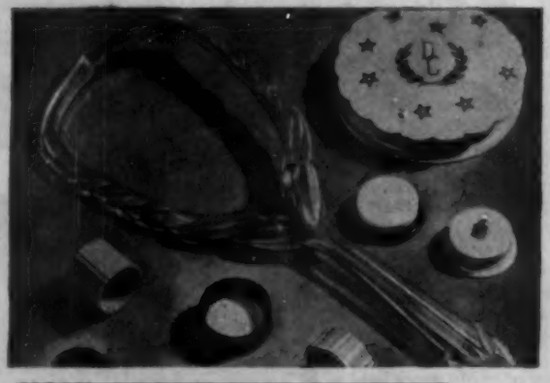
Want repeat sales or consumer goodwill? Better make your product right the first time. Test it, try it, use it—as many times as you would if you were buying it for yourself.



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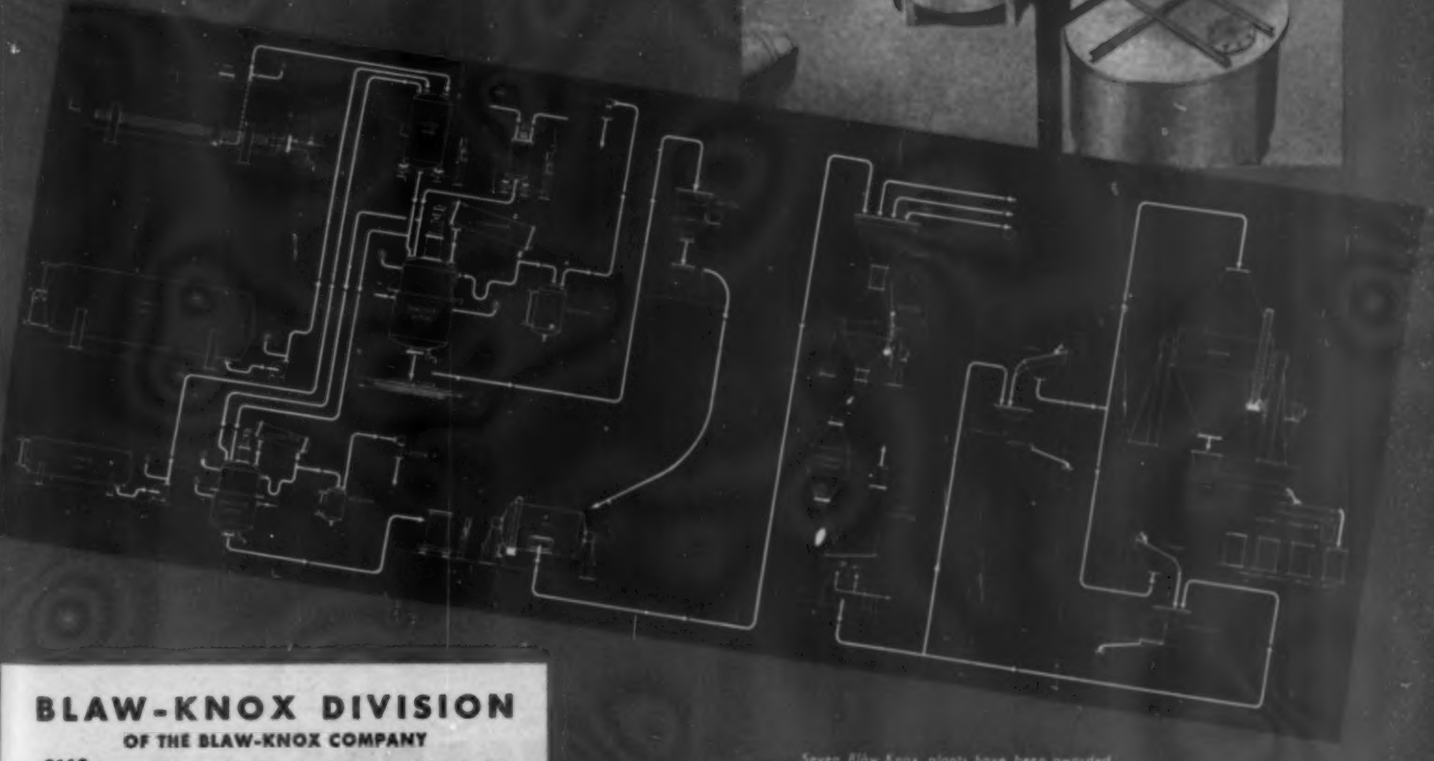

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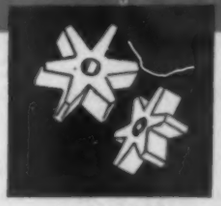

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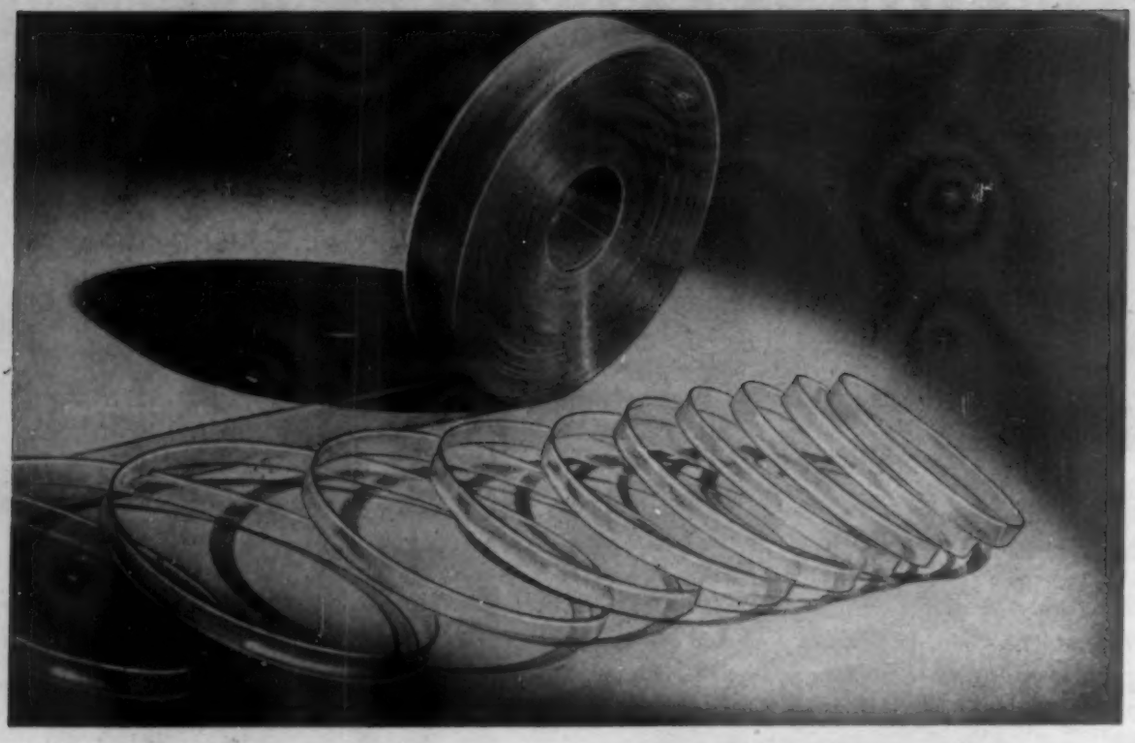

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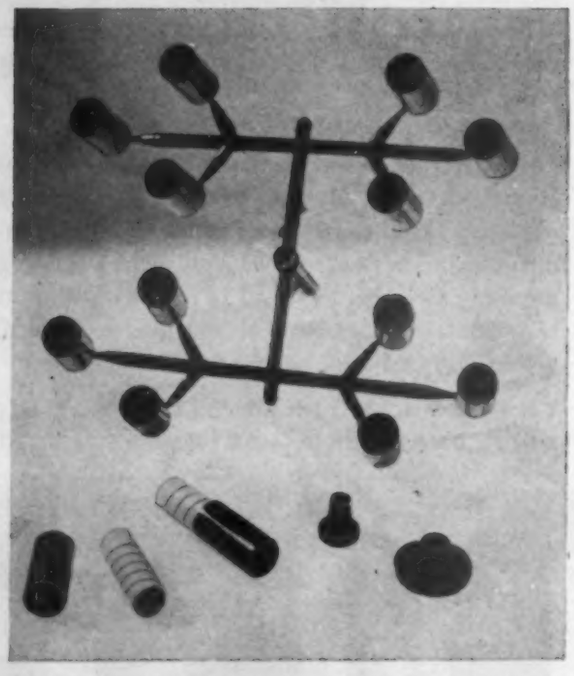

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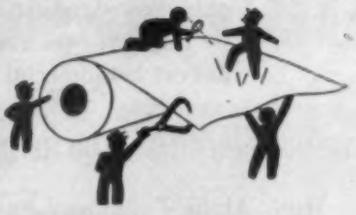

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We also do injection molding.

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...under foot...

Foot-operated base of the Septisol Soap Dispenser made by the Vestal Chemical Laboratories, Inc., St. Louis, Missouri. Plastic housing of base molded by Imperial. Below are shown the dis-assembled plastic parts

• This foot-operated surgical soap dispenser heralds a step forward in the use of molded plastics by the Vestal Chemical Laboratories, Inc., St. Louis. This fine unit is ideally suited for hospitals, clinics and other such institutions where soap must be instantly available but where hands must not touch the dispenser.

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This base is just one of the many ways in which Imperial Molded is solving problems in the use of molded plastics.

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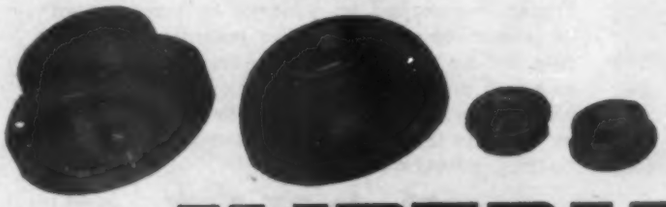

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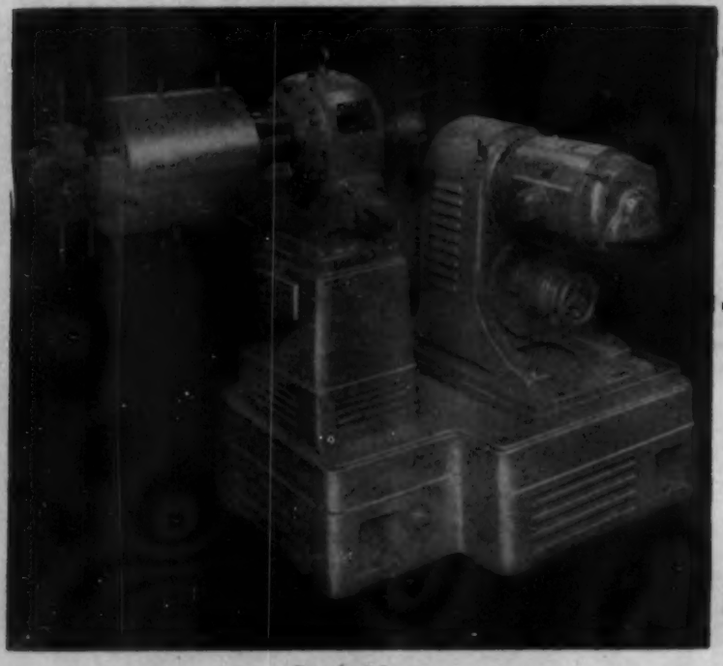

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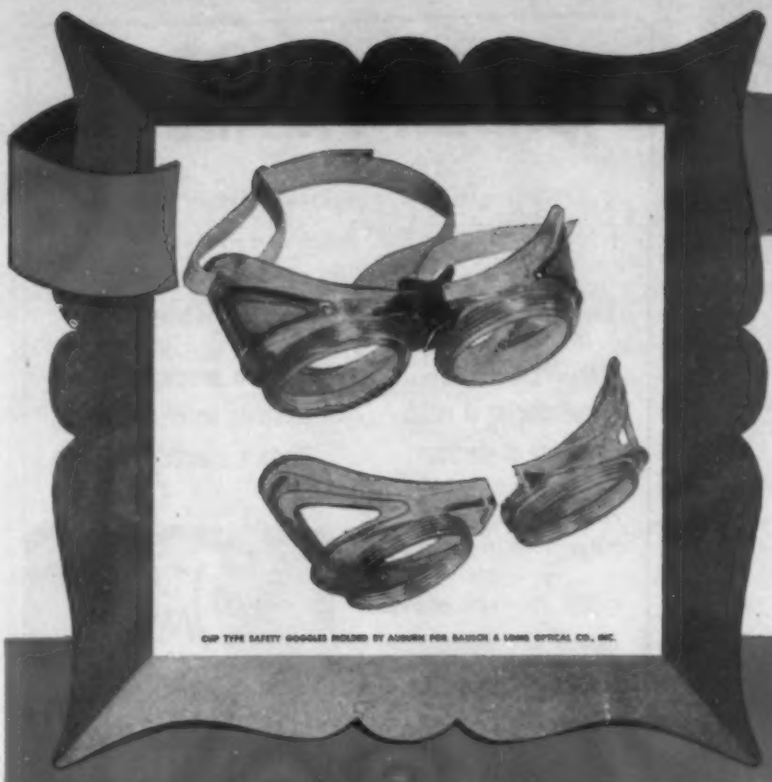

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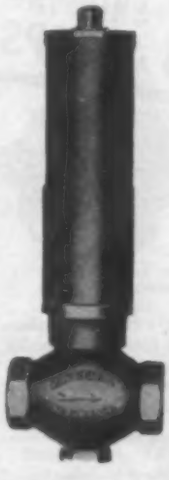

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High Pressure Reducing Valve

It handles easily—without the slightest shock—pressures up to 6,000 lb. per sq. in. —oil, water, or air. It is ideal for plastics plants.

You will Like It

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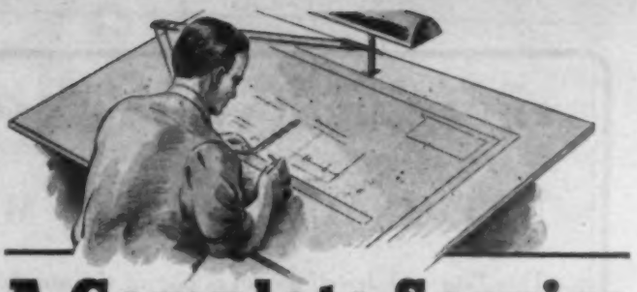
PYROMETERS

Bulletin 194-S gives details of these instruments. They help save money and make better plastics.



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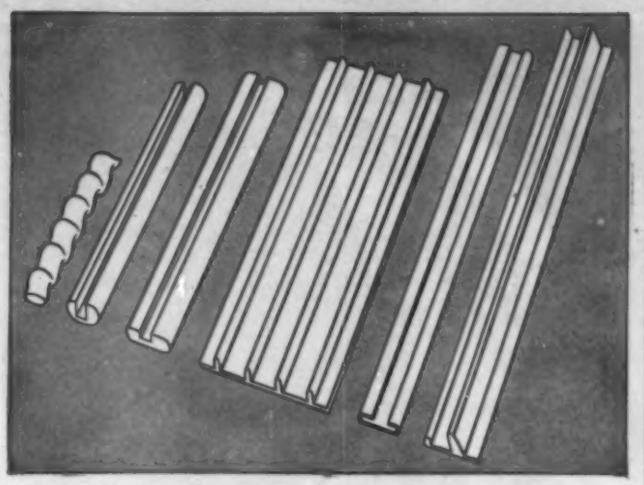

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Plastics

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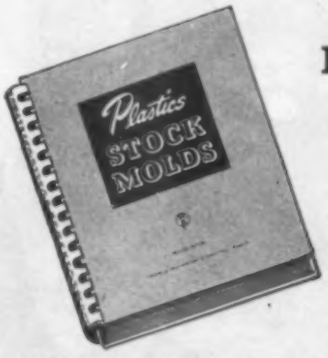

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PLASTICS STOCK MOLDS

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A NEW LINE OF STANDARD TAPERED CUTTERS

Patent No. 2113178

Another time-saving development to help the mold-maker. DME now offers new standard tapered cutters which enable you to cut draft or relief directly into cavity or core without the necessity of tilting the machine head or changing the setup.

These tapered cutters have a constant, uniform spiral angle the entire length of the taper. They are made of high speed steel with three spiral flutes, provide greater strength than two flute cutters and make for faster, smoother cutting.

You'll find many applications for DME Tapered Cutters in your plastic mold-making operations. Complete stock—immediate delivery.

CUTTER SPECIFICATIONS

- Flute lengths range from ½" to 3¼".
- Available in ½, 1, 2, 3, 5 and 7 degree tapers.
- Small end sizes: ⅛" to ½" O. D.

Send for DME NEWS (No. 4-3) for detailed information on tapered cutters

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SIMONDS SAW

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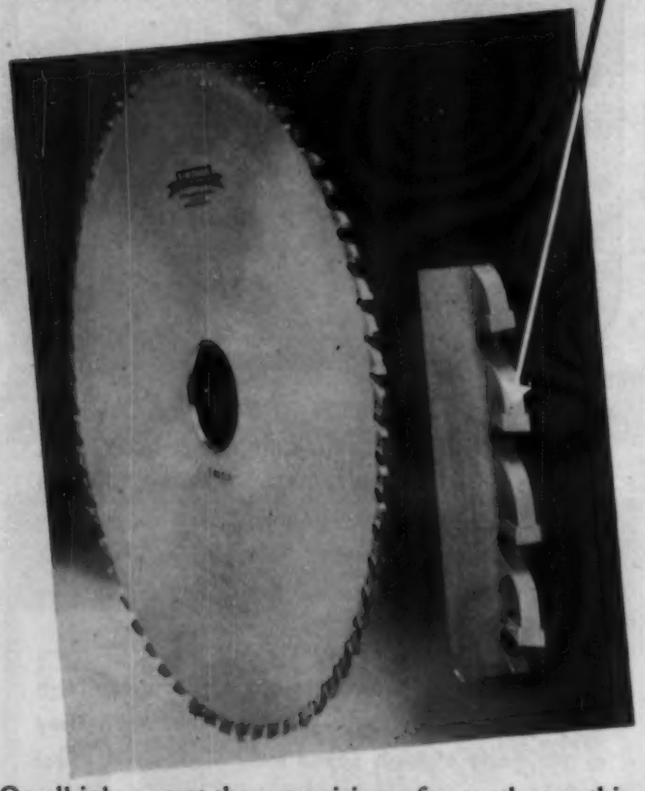

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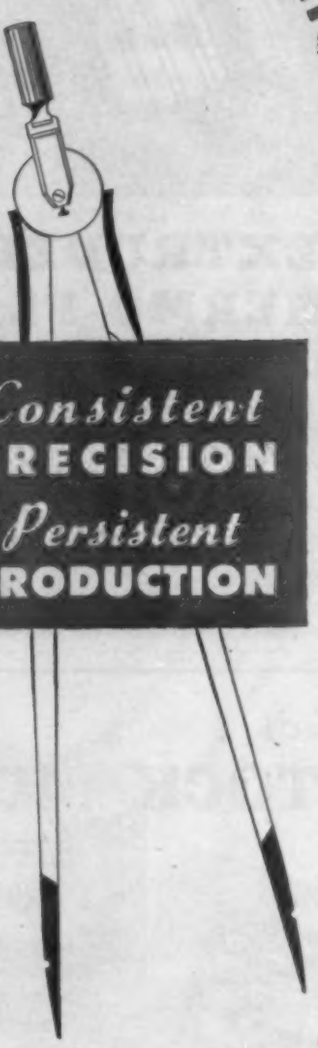

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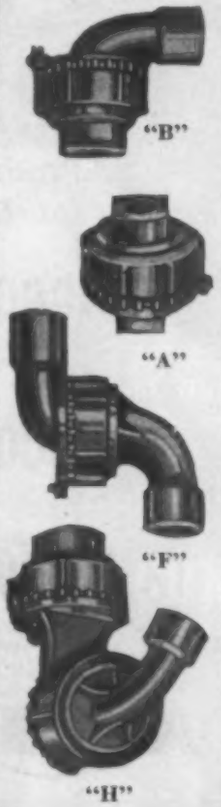

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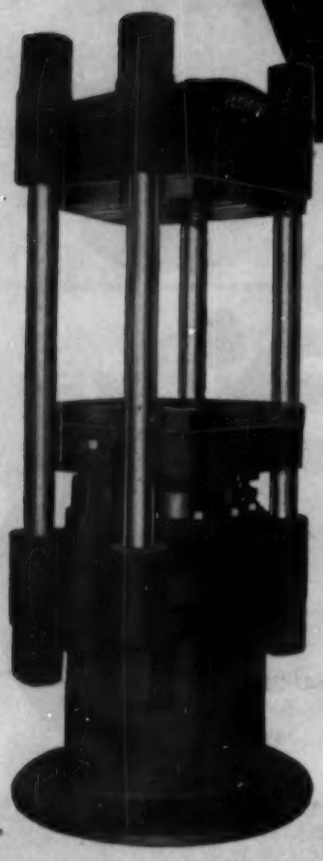

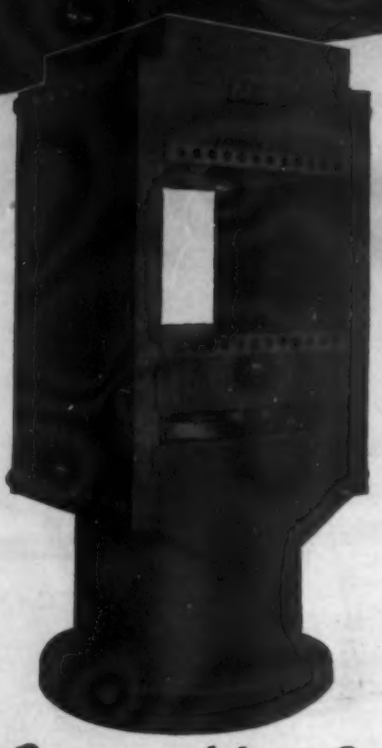

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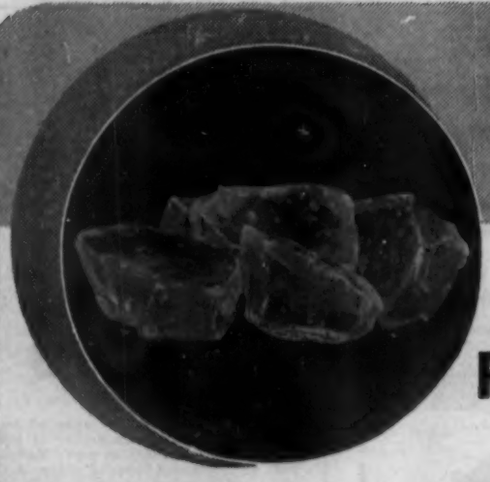

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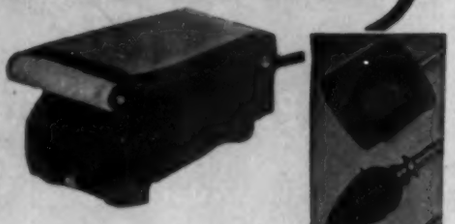

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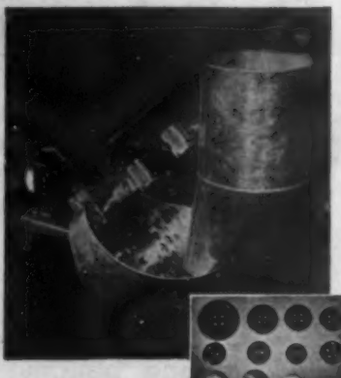

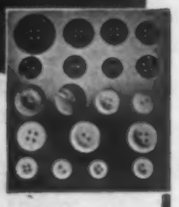

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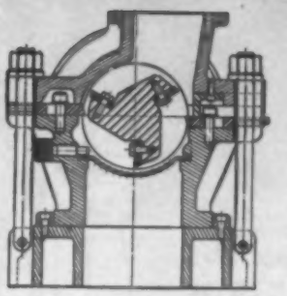

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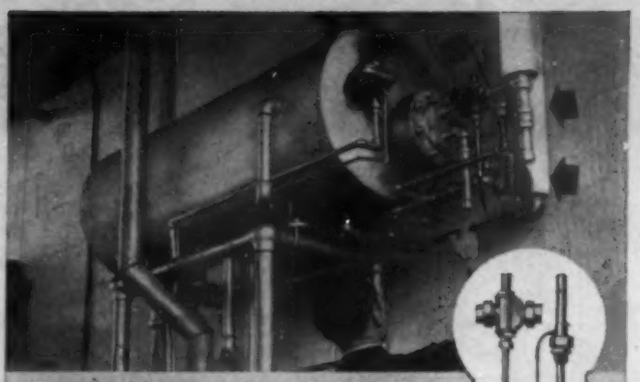

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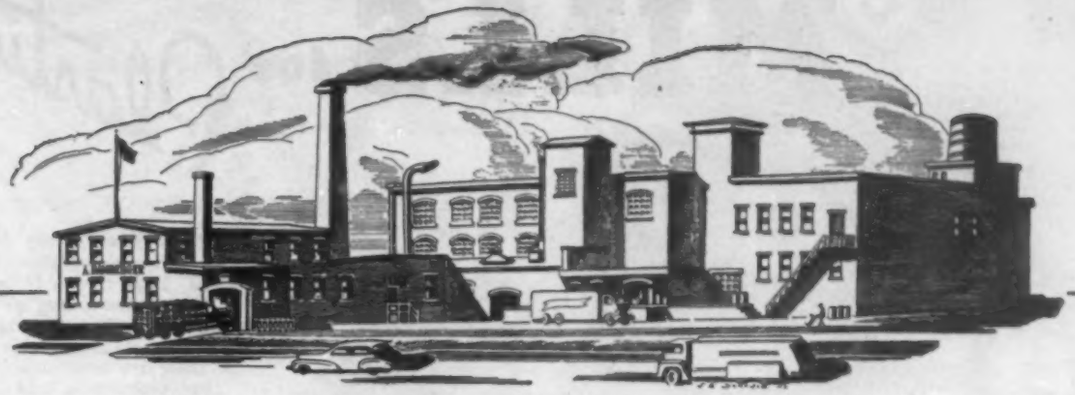

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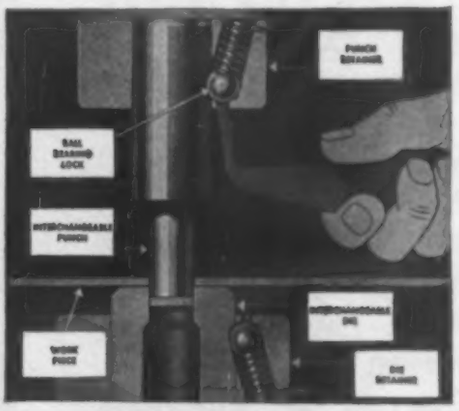

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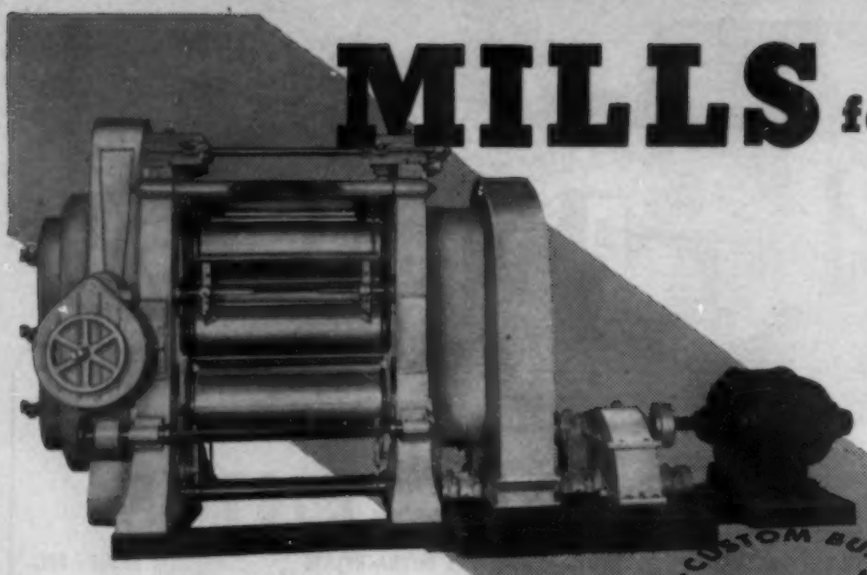

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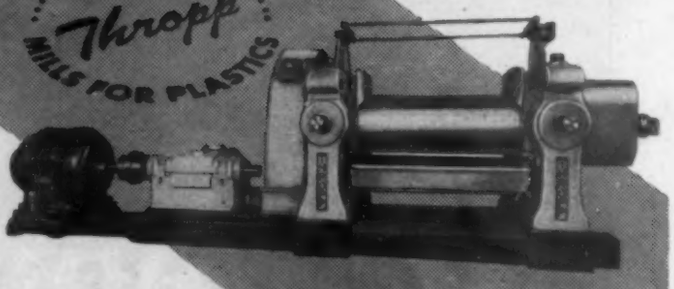

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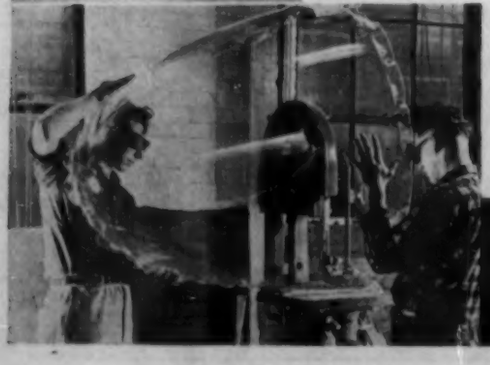
Left—W-T 15" Drill Press, Bench Model, spindle speed 600 to 5000 R.P.M. with 1740 R.P.M. motor.

Below — W-T 16" Band Saw.



Check! WALKER-TURNER DRILL PRESSES for plastics, plywoods and other laminated materials. Spindle assembly aligned in four ball bearings, with pulleys straddle-mounted between bearings to eliminate whip. Wide speed ranges permit selection of *correct* spindle speed for each material. Hand or power feed, 15" and 20" models. .....

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Plastic Molding

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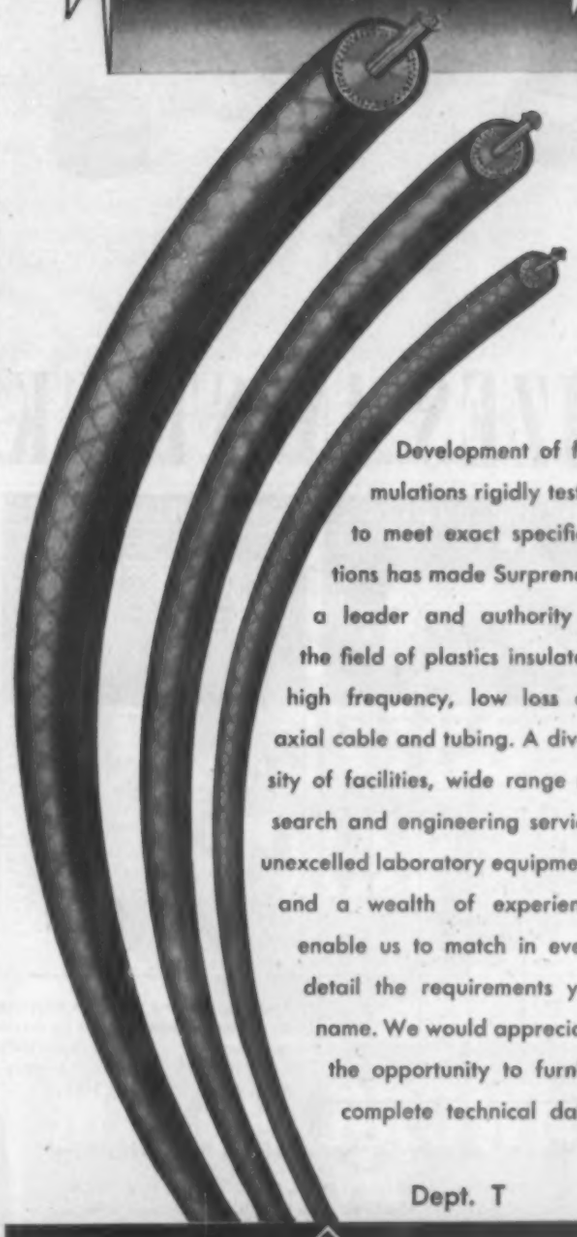

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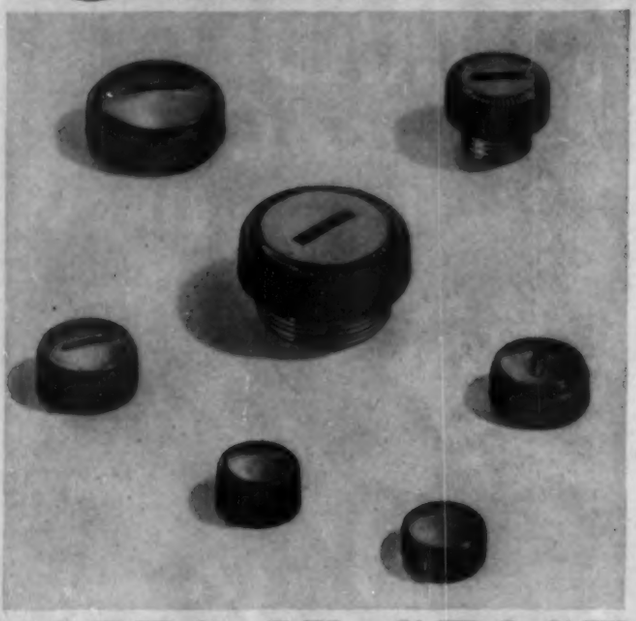
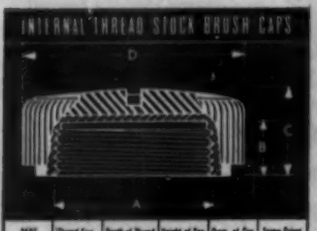


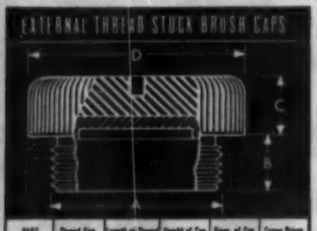
SIZES IN STOCK

INTERNAL THREAD STOCK BRUSH CAPS



PART NUMBER	Thread Size "A"	Depth of Thread "B"	Height of Cap "C"	Diam. of Cap "D"	Screw Driver SLOT
017	9/16-27	1/8	13/64	1/2	YES
016	5/8-27	9/64	11/32	9/16	YES
040	5/8-27	5/32	7/32	9/16	YES
042	5/8-27	5/32	9/16	9/16	NO
043	5/8-27	13/64	1/2	9/16	NO
045	11/16-27	5/32	9/16	11/16	YES
131	11/16-27	5/32	9/16	11/16	NO
044	1/2-27	5/32	7/32	1/2	YES
138	9/16-27	9/64	13/32	29/64	YES
073	5/8-27	9/64	13/64	5/8	YES
053	13/16-27	9/64	13/32	1"	YES
139	5/8-27	7/32	29/64	1"	YES
150	15/16-27	15/64	9/32	31/64	YES
101	1 1/16-27	1/4	1/2	39/64	YES

EXTERNAL THREAD STOCK BRUSH CAPS



PART NUMBER	Thread Size "A"	Length of Thread "B"	Height of Cap "C"	Diam. of Cap "D"	Screw Driver SLOT
027	9/16-27	9/64	9/64	17/32	YES
209	5/8-32	9/64	9/64	17/32	YES
028	9/16-27	5/32	9/64	9/16	YES
041	1/2-20	1/4	9/32	1/2	YES
210	9/16-27	13/64	1/4	37/64	YES
181	5/8-27	9/64	1/4	39/64	YES
054	7/16-27	5/32	1/4	39/64	YES
220	15/16-24	15/64	9/64	23/64	YES
613	15/16-27	7/32	9/32	3/4	YES

Prices on request • some variations from listed dimensions can be made to order • Molded parts Black only • Metal inserts plated to specifications: Silver, Cadmium, Nickel.

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to fit above sizes in brush caps, or both caps and holders can be made to specifications . . . all plastic, or with inserts . . . from molds furnished, or we can make molds

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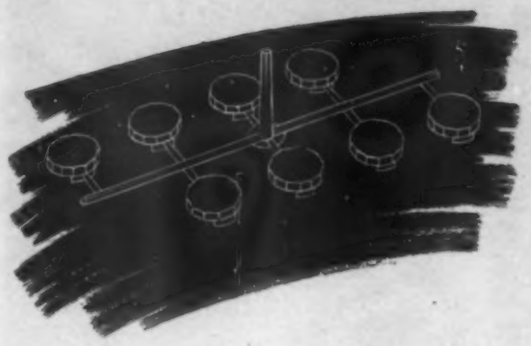

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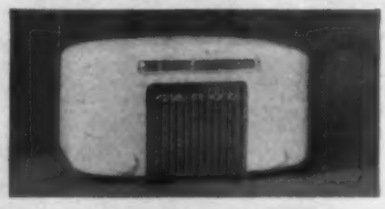

★ Designed in charming simplicity, the plastic case of this new Garod Radio is molded by Waterbury Companies, Inc., pioneer molders of plastic in America.

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Formerly Waterbury Button Co., Est. 1812

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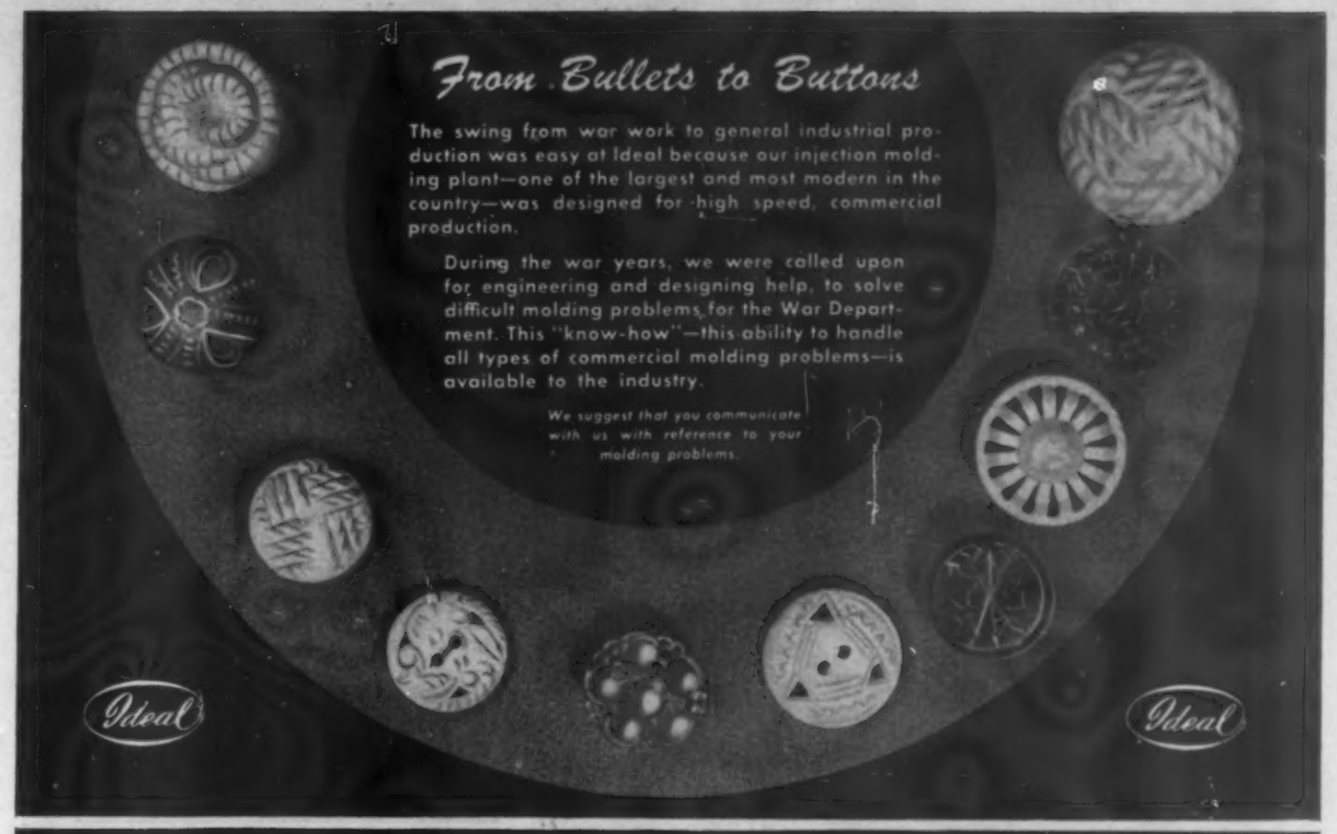
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The swing from war work to general industrial production was easy at Ideal because our injection molding plant—one of the largest and most modern in the country—was designed for high speed, commercial production.
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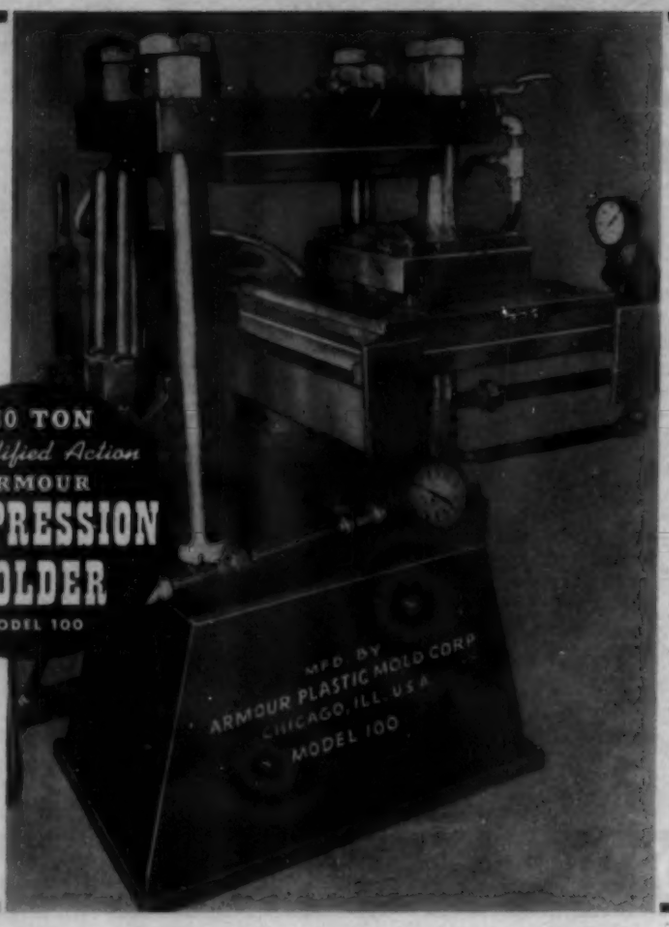

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in a small area—by unskilled help

Clean, uniform plastics are everyday routine on this compact, semi-automatic compression molder. Unskilled operators can maintain maximum production, in a 20x30 foot area, housing 6 presses, steam generator, pre-heating tables and hydraulic system.

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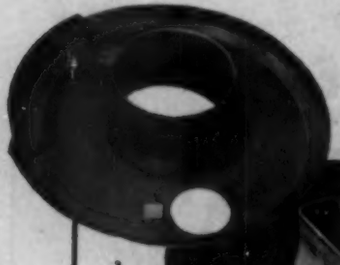
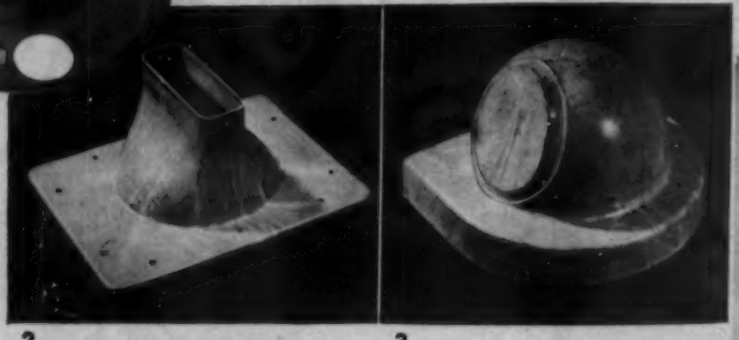


1.



2. 3.

4.

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Göteborg H Sweden

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Branch of the Industry	Name of Appliance	Use
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Molders (Thermosetting) Compression	PELLET-VEYOR (Variable heat)	To preheat pellets and preforms at the press as needed
Injection	HOPPER-HEATER (Variable heat)	To warm up heavy metal of hopper of molding machine
Molders (Thermoplastic) Extrusion	STRIP-HEATER (Variable heat)	To preheat strip rolls of vinylite, etc., automatically as fed to worm
Material Manufacturers	Special production equipment including vibrators, conveyors, stainless steel belts and electronic devices	To process various kinds of plastic material in bulk
Fabricators (Miscellaneous)	BENCH-KIT In various sizes (Variable heat)	To soften sheets, rods, tubes and any shape for bending, forming, punching, etc. This includes Cellulose, Acetate, Methyl Methacrylate

(The time on most of the operations mentioned above averages five minutes)

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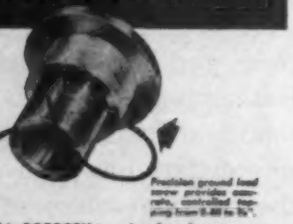

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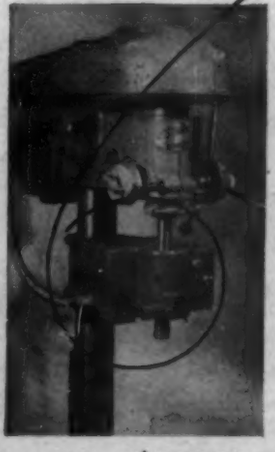

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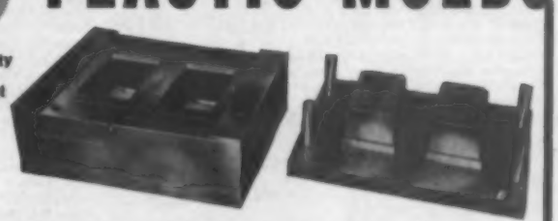

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INDEX TO ADVERTISEMENTS

A & P Engineering & Mfg. Co., Inc. 226
Able Machine & Tool Works 233
Accurate Molding Corp. 221
Advance Solvents & Chemical Corp. 216
Airtronics Mfg. Co. 171
Ajax Steel & Forge Co. 210
Allied Products Corp. 176, 231
American Cyanamid Co. 130–131
American Phenolic Corp. 55
American Plastics Corp. 219
American Rotary Tools Co., Inc. 224
American Screw Co. 32, 39
Amos Molded Plastics 19
Anigraphic Process, Inc. 218
Antique Electro Finishing Co. 223
Armour Plastic Molding Corp. 240
Arnkurt Associate Engineers 232
Aro Equipment Corp., The 46
Atlantic Screw Works 39
Atlas Bolt & Screw Co. 39
Atlas Valve Co. 217
Auburn Button Works 215

Bakelite Corp. ..... Inside Back Cover
Baker Castor Oil, The 163
Baldwin Locomotive Works, Baldwin Southwark Div. 196
Ball & Jewell 217
Bamberger, A. 231
Bell Telephone Laboratories 20
Blaw Knox Co. 195
Boonton Molding Co. 174
Bridgeport Moulded Products, Inc. 28
Brilhart, Arnold, Ltd. 183
Buttondex Corp. 224

Cambridge Instrument Co., Inc. 218
Carver, Fred S. 170
Catalin Corp. 3
Cavagnaro, John J. 231
Celanese Plastics Corp. 11
Celluplastic Corp. 200
Central Screw Co. 39
Chandler Products Corp. 39
Chemaco Corp. 22
Chicago Molded Products Corp. 167
Ciba Products Corp. 225
Claremont Waste Mfg. Co. 140
Classified 242, 244
Columbia Protektosite Co., Inc. 38
Connecticut Plastic Products Co. 211
Consolidated Molded Products Corp. 157
Continental-Diamond Fibre Co. 35
Continental Plastics Corp. 223
Continental Screw Co. 39
Corbin Screw Div. 39
Corning Glass Works 13
Creative Printmakers, Inc. 238
Cruver Mfg. Co. 21
Cumberland Engineering Co. 229
Curran & Barry 204

Dasor Mfg. Co. 14
DeMattia Machine Tool Co. 26
Denison Engineering Co., The 199
Detroit Macoid Corp. 207
Detroit Mold Engineering Co. 219
DoAll Co., The 241
Douglas Machinery Co., Inc. 244
Dow Chemical Co., The 51
Drakenfeld, B. F. & Co., Inc. 212
du Pont de Nemours, E. I. & Co., Inc., Electrochemicals Dept. 29
du Pont de Nemours, E. I. & Co., Inc., Plastics Div. 37
Durez Plastics & Chemicals, Inc. ..... Inside Front Cover
Durite Plastics, Inc. 24

Elmes Engineering Works of American Steel Foundaries 49
Emeloid Co., Inc., The 191
Engineering Specialities Corp. 227
Erie Engine & Mfg. Co. 222
Erie Resistor Corp. 27
Exact Weight Scale Co. 206

Fabricon Products, Inc. 217
Farrel-Birmingham Co., Inc. 59
Federal Telephone & Radio Corp. 63
Felsenthal, G. & Sons 213
Fisher Chemical Co. 213
Flexo Supply Co., Inc. 221
Fortney Mfg. Co. 223
Franklin Plastics Div. 208

General American Transportation Corp. 16–17
General Chemical Co. 201
General Electric Co. ..... Back Cover
General Industries Co., The 139
General Molded Products, Inc. 61
Gering Products, Inc. 226
Girdler Corp. 193
Gits Molding Corp. 238
Goodrich, B. F., Chemical Co. 5
Greenhut Insulation Co. 208

Hannifin Mfg. Co. 228
Harper, H. M., Co, The 39
Hercules Powder Co. 72
Hommer Tool & Mfg. Co. 216
Huntington Stamping & Plastic Co., Inc. 229
Hydraulic Press Mfg. Co., The 161

Ideal Plastics Corp. 239
Imperial Molded Products Co. 209
Industrial Molded Products Co. 42
Interlake Chemical Corp., Makalot Div. 9
International Screw Co. 39

Jorgensen Mfg. Co. 239

Kenilworth Plastics Molding Co. 214
Keyes Fibre Co. 31
Kingsley Gold Stamping Machine Co. 245
Kuhn & Jacob Molding & Tool Co. 233
Kurz-Kasch, Inc. 30

Lake Erie Engineering Corp. 202
Lakone Co., The 237
Lamson & Sessions Co., The 39
Lane, J. H. & Co., Inc. 229
Leominster Tool Co., Inc. 173
Lester-Phoenix, Inc. 36
Lucidol Div., Novadel-Agene Corp. 212

Mack Molding Co., Inc. 194
Magnetic Plastics Co., The 230
Manufacturers Chemical Corp. 22
Manufacturers Screw Products 39
Marblette Corp., The 47
Martindell Molding Co. 204
Mearl Corp., The 232
Metal Specialty Co., The 230
Meyer & Brown Corp. 237
Michigan Molded Plastics, Inc. 181
Midwest Molding & Mfg. Co. 236
Milford Rivet & Machine Co. 39, 214
Mills, Elmer E., Corp. 71
Minneapolis Plastics Molders, Inc. 179
Minnesota Plastics Corp. 58
Miskella Infra-Red Co., The 241
Monsanto Chemical Co. 52, 187
Mosinee Paper Mills Co. 69
Muehlstein, H. & Co., Inc. 212
Munising Paper Co., The 206
Myler Plastics Corp. 211

National Lock Co. 39
National Organ Supply Co. 214
National Plastic Products Co., The 235
National Rubber Machinery Co. 25
National Screw & Mfg. Co. 39, 74
National Vulcanized Fibre Co. 23
Neville Co., The 18
Nemo Mastercraft Co. 216
Newark Die Co., Inc. 208
New England Screw Co. 39
New Hampshire State Planning & Development Comm. 138
New Jersey Zinc Co., The 10
New York Air Brake Co., The 73
Niacet Chemical Div. of U. S. Vanadium Corp. 192
Nixon Nitration Works 15
North American Electric Lamp Co. 215
Northern Industrial Chemical Co. 224
Norton Laboratories, Inc. 159

Owens-Corning Fiberglas Corp. 198

Palm Fechteler & Co. 190
Parker-Kalon Corp. 39, 50
Pawtucket Screw Co. 39
Pheoll Mfg. Co. 39
Phillips Screw Manufacturers 39
Plaskon Div. 124–125
Plastic & Die Cast Products Corp. 220
Plastic Engineering, Inc. 234
Plastic Enterprises, Inc. 225
Plastic Film Corp. 175, 203
Plastic Finishing Corp. 228
Plastic Manufacturers, Inc. 168
Plastics Catalogue Corp. 197
Plastics Industries Technical Institute 54
Plastics Stock Molds 219
Plastimold, Inc. 213
Plax Corp. 41
Portable Products Corp., C. J. Tagliabue Div. 64
Porter Cable Machine Co. 53
Preis, H. P., Engraving Machine Co. 221
Pro-phy-lac-tic Brush Co., Prolon Plastics Div. 12
Putnam Tool & Die Co. Inc. 211

Quarnstrom Tool Co. 245

Racine Tool & Machine Co. 57
Radio Receptor Co., Inc. 185
Ranaverken, Aktiebolaget 241
Rayon Processing Co. of R. I. 227
Reading Screw Co. 39
Recto Molded Products, Inc. 228
Reed-Prentice Corp. 8
Reichhold Chemicals, Inc. 68
Remler Co., Ltd. 235
Richardson Co., The 6
Robinson Industries, Inc. 208
Rogan Bros. 226
Rohm & Haas Co. 155
Royle, John & Sons 210
Russell Burdsall & Ward Bolt & Nut Co. 39

St. Louis Plastic Moulding Co. 62
Sarco Co., Inc. 230
Schauer Machine Co. 245
Schwartz Chemical Co. 206
Scovill Mfg. Co. 39
Shakeproof, Inc. 39
Shaw Insulator Corp. 40
Simonds Saw & Steel Co. 220
Smith, Carlton, Industries 56
Southern Chemical Cotton Co. 205
Southington Hardware Mfg. Co., The 39
Standard Chemical Co. 222
Standard Tool Co. 237
Steel Co. of Canada Ltd., The 39
Stensgaard, W. L., & Associates, Inc. 239
Sterling Advertising Agency 244
Sterling Bolt Co. 39
Stokes, F. J., Machine Co. 60
Stricker Brunhuber Co. 236
Surprenant Electrical Insulation Co. 235
Swedlow Plastics Co. 177
Synthetic Resins, Ltd. 227

Tagliabue, C. J., Div. Porter Products Corp. 64
Taylor Mfg. Co. 218
Tech-Art Plastics Co. 165
Tennessee Eastman Corp. 137
Thompson, H. C., Clock Co. 215
Thropp, Wm. R., & Sons Co. 232
Timken Roller Bearing Co., The 43, 67
Tinnerman Products, Inc. 65

Union Carbide & Carbon Co. ..... Inside Back Cover
Union Pacific Railroad 70
Universal Plastics Corp. 189

Valentine Sugars, Valite Div. 233
Van Dorn Iron Works Co., The 169
Varcum Chemical Corp. 33
Velepec, Fred M., Co. 236
Vulcanized Rubber & Plastics Co. 243

Walker-Turner Co., Inc. 234
War Assets Administration 66
Waterbury Companies, Inc. 238
Watlow Electric Mfg. Co. 192
Watson-Stillman Co. 34
Western Products, Inc. 172
Westinghouse Electric Corp. 44–45
White, S. S., Dental Mfg. Co., The 218
White, Thos. J., Plastics Co. 240
Wilson Gold Stamping Machine Co. 204
Witco Chemical Co. 48
Wolverine Bolt Co. 39
Worcester Moulded Plastics Co. 248

Youngstown Miller Co., The 247

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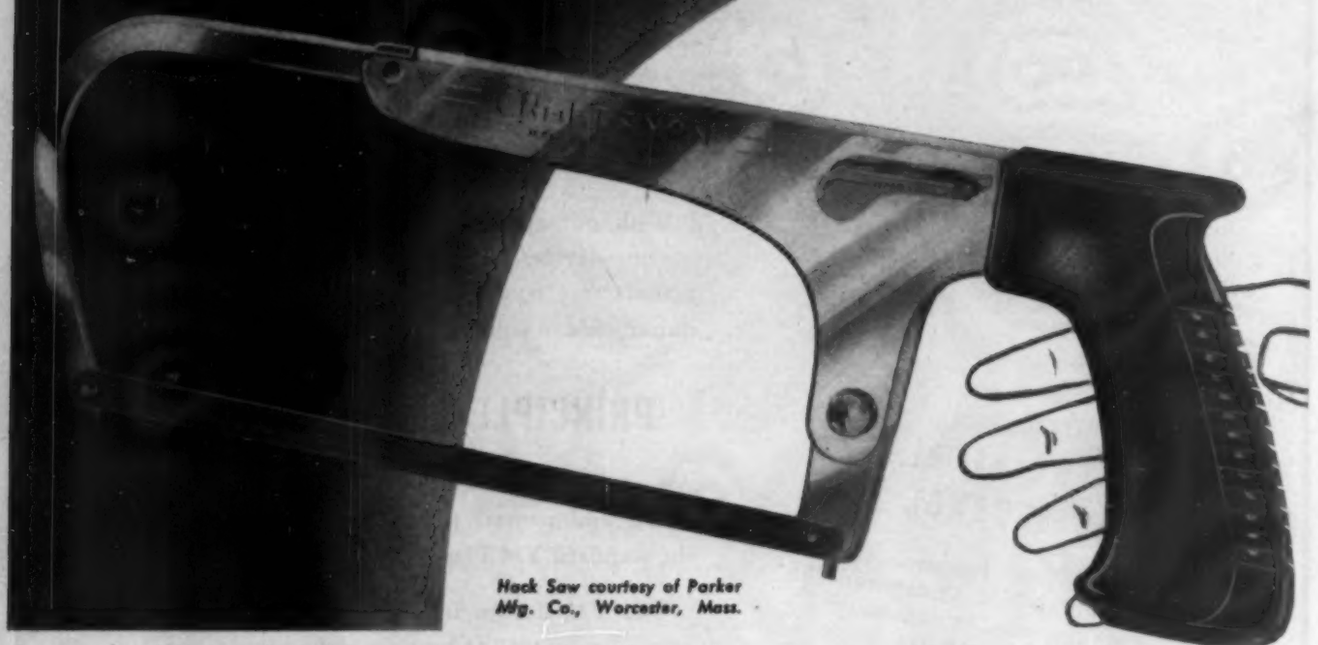

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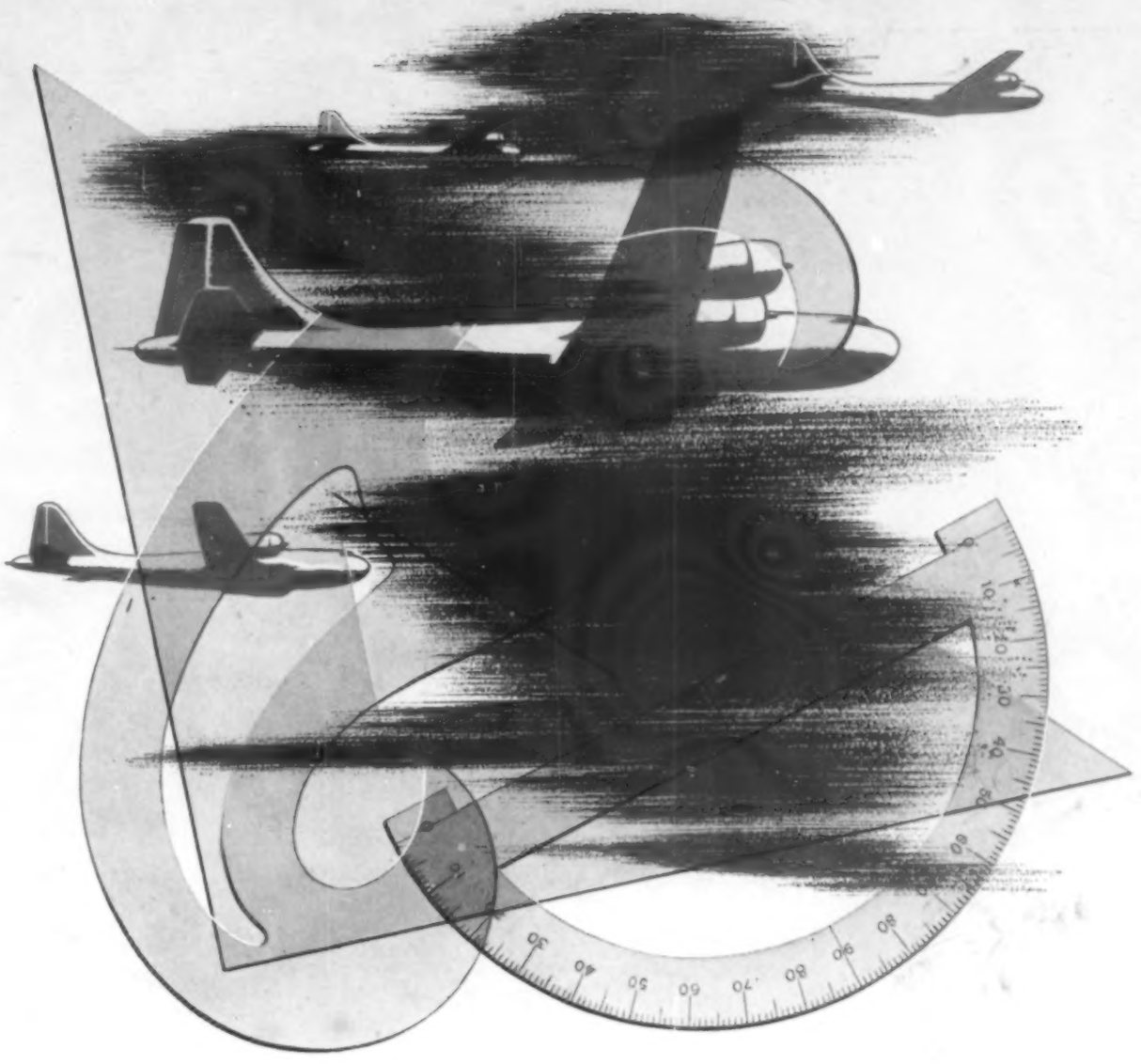

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But VINYLITE plastic rigid sheets are not limited to the transparent type. They come in translucent and opaque—in many colors, and several standard thicknesses and finishes. And transparent or otherwise, they open to designers and industry visions of new opportunities for product improvement and manufacturing economy. This rigid sheet material won't shrink, stretch, or warp through a wide range of temperature and atmospheric changes. It's lightweight; high in tensile strength; non-flammable; and outstandingly resistant to chemicals, moisture, sunlight, and abrasion. Further, it readily takes and holds close-register printing . . . and it's machined and formed on standard metal-working equipment.

Write Department 7-1 for booklet S-1, "VINYLITE Plastic Rigid Sheets." It gives detailed information about this versatile material and indicates the remarkable scope for its profitable application.

VINYLITE PLASTICS

TRADE-MARK

BAKELITE CORPORATION, *Unit of Union Carbide and Carbon Corporation* UCC 30 EAST 42ND STREET, NEW YORK 17, NEW YORK

DESIGNED AND ENGINEERED AT NO. 1 PLASTICS AVENUE
PROBLEM—
MAKE A FACTORY TRUCK WHEEL...
MUST NOT STRIKE SPARKS...
MUST BE ADAPTABLE TO ANY TYPE OF BEARING

PLASTICS . . . FOR SMOOTHER ROLLING TRUCK WHEELS

● More and more factory trucks are rolling on plastic wheels. Designed at No. 1 Plastics Avenue, these are made by General Electric for the Service Caster & Truck Company.

No wonder they are so widely used in industry. Compression-molded laminates of chopped duck cloth and phenolic, these truck wheels are rugged...economical...impervious to moisture and chemical action. They outwear metal wheels, reduce wear and tear on factory floors, and do not strike sparks.

Not all plastics are glamorous. The factory truck wheel is typical of hundreds of workaday plastics products that have been produced by G.E.'s *complete* plastics service to do a better job, or a job that only plastics can do.

Check on the progress in the development of heavy-duty industrial plastics. Bring any kind of plastics problem to General Electric—the world's largest manufacturer of plastics parts. Write to Plastics Divisions, General Electric Co., 1 Plastics Avenue, Pittsfield, Mass. *We shall be glad to send you upon request a copy of the new illustrated booklet, "What Are Plastics?"*

EVERYTHING IN *Plastics*

G-E Complete Service—Everything in Plastics

Backed by 51 years of experience. We've been designing and manufacturing plastics products ever since 1894. G-E Research works continually to develop new materials, new processes, new applications.

No. 1 Plastics Avenue—complete plastics service—engineering, design and mold-making. Our own industrial designers and engineers, working together, create plastics parts that are both scientifically sound and good-looking. Our own toolrooms are manned by skilled craftsmen—average precision mold experience, 12 years.

All types of plastics. Facilities for compression, injection, transfer and cold molding . . . for both high and low pressure laminating . . . for fabricating. And G-E Quality Control—a byword in industry—means as many as 160 inspections and analyses for a single plastic part.

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General Electric plastics factories are located in Fort Wayne, Ind., Meriden, Conn., Scranton, Pa., Taunton, West Lynn, and Pittsfield, Mass.